US006112879A

United States Patent [19]

Fortenbery et al.

[11] **Patent Number: 6,112,879**

[45] **Date of Patent: *Sep. 5, 2000**

[54] **TILTING CART FOR A PACKAGE SORTING CONVEYOR**

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[73] Assignee: **Mantissa Corporation**, Charlotte, N.C.

[*] Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

This patent is subject to a terminal disclaimer.

[21] Appl. No.: **09/192,948**

[22] Filed: **Nov. 16, 1998**

Related U.S. Application Data

[63] Continuation of application No. 08/632,012, Apr. 15, 1996, Pat. No. 5,836,436.

[51] **Int. Cl.**[7] **B65G 47/10**

[52] **U.S. Cl.** **198/370.04**; 198/805

[58] **Field of Search** 198/370.03, 370.04, 198/805; 209/912

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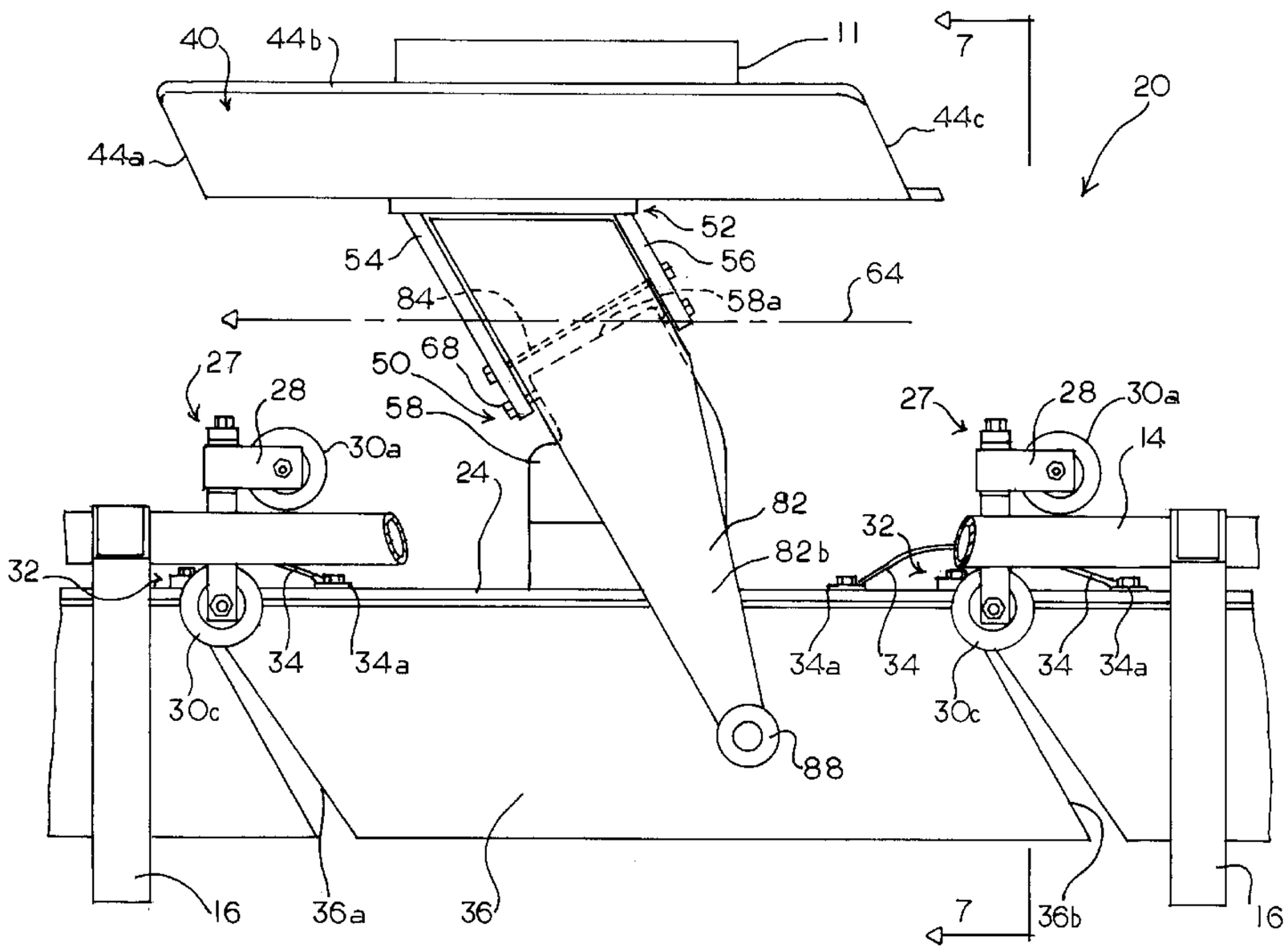
Primary Examiner—Jospeh E. Valenza
Attorney, Agent, or Firm—Rhodes & Mason, PLLC

[57] **ABSTRACT**

A package sorting conveyor system having at least one conveyor cart movable along a continuous track and at least one unloading station. The conveyor system includes a two-axis tiltable support apparatus for supporting the carrying tray on the conveyor cart and for allowing tilting of the carrying tray towards at least one side of the package sorting conveyor to unload a package into unloading stations on at least one side of the sorting conveyor. A transition zone funnel upstream of the unloading station receives the package from the conveyor cart. The transition zone funnel includes an inlet adjacent to the continuous track conveyor system at the unloading station for receiving the package discharged from the tiltable conveyor cart; an upwardly inclined downstream wall located downstream of the inlet for preventing the package from tipping over; and an outlet located downstream from the upwardly inclined downstream wall for discharging the package from the funnel. In the preferred embodiment, a secondary downstream chute is located downstream from the transition zone funnel for conveying the discharged package to its final destination.

36 Claims, 14 Drawing Sheets



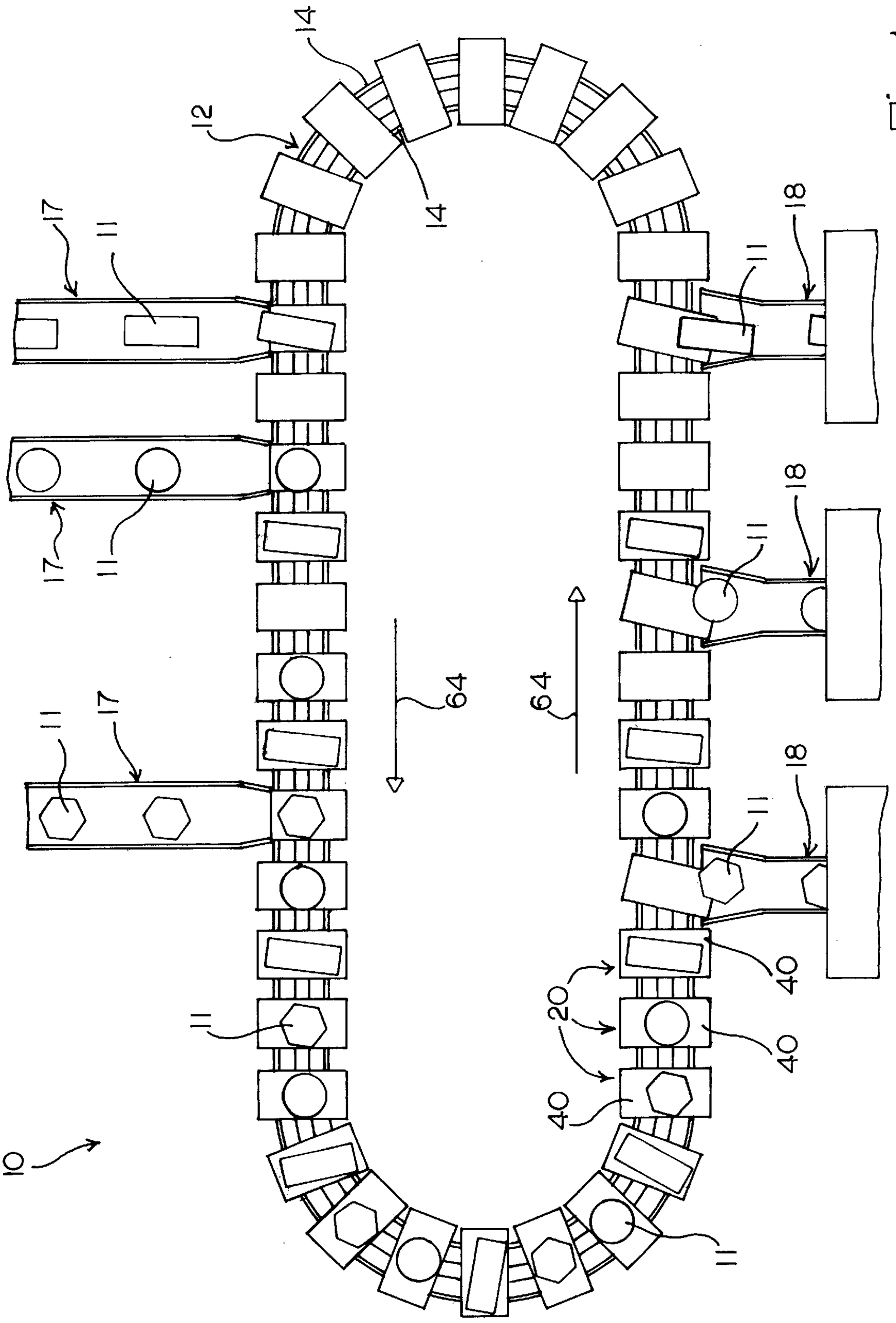

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Fig. 1

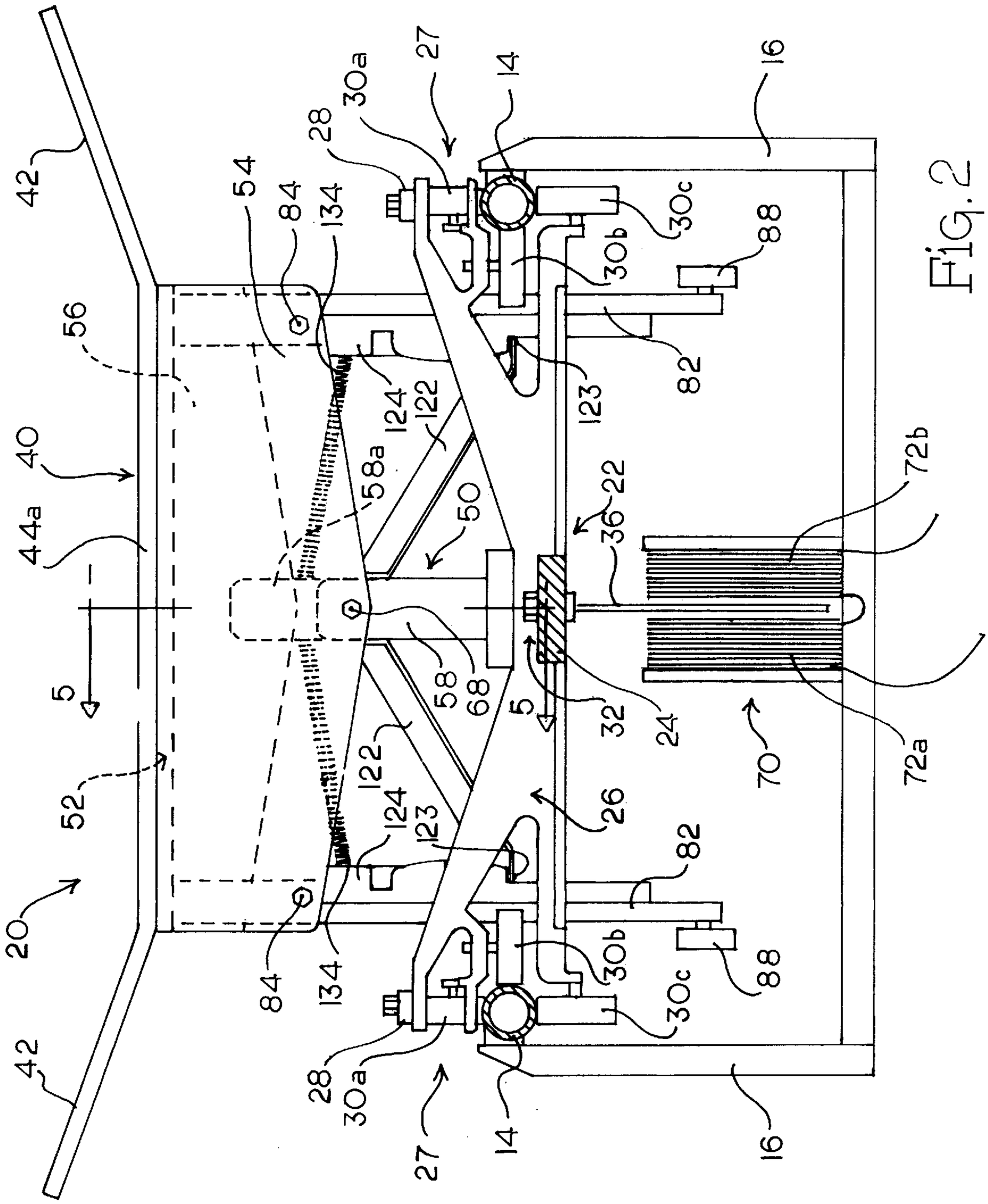
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FIG. 2

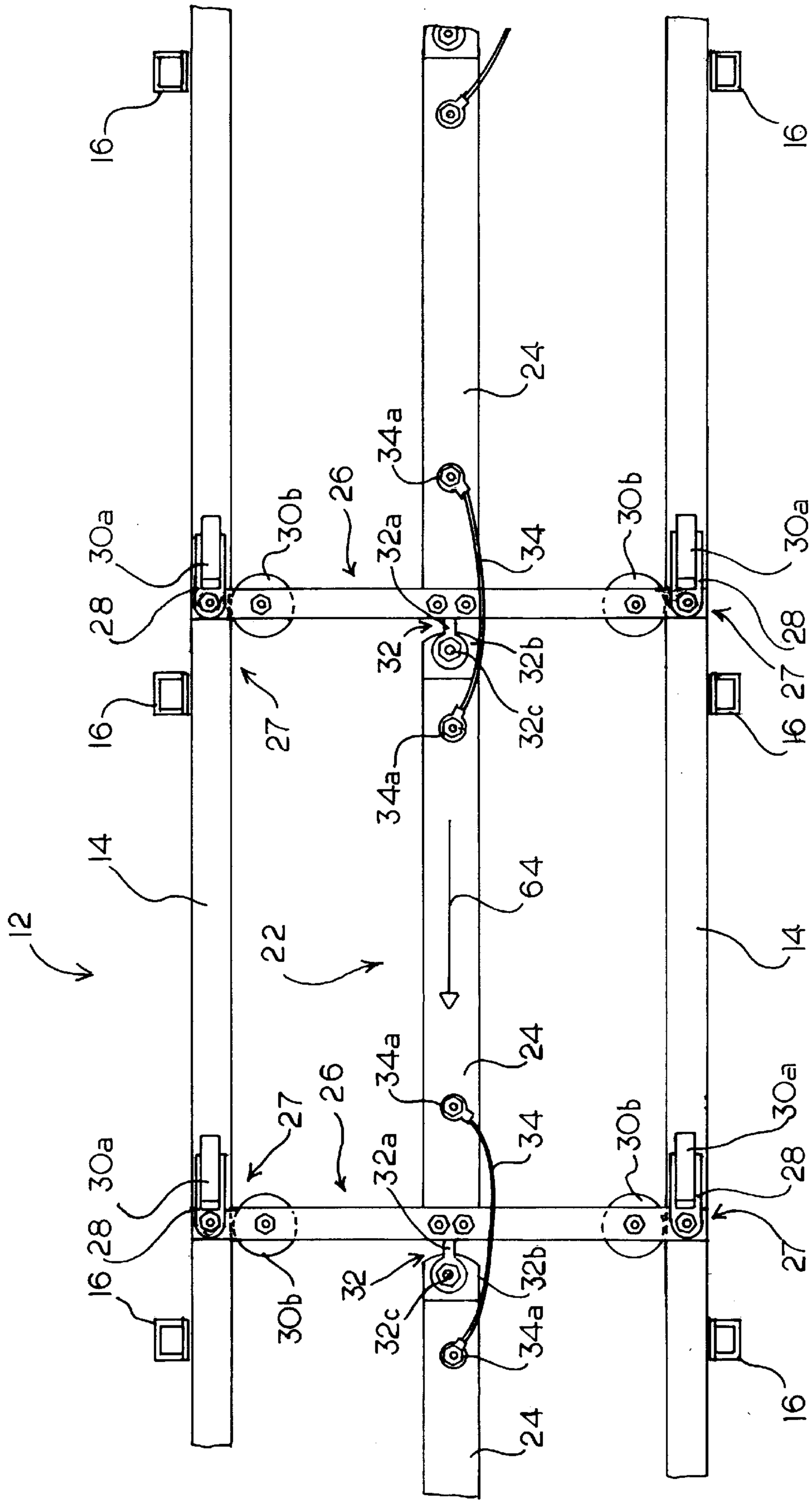
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Fig. 3

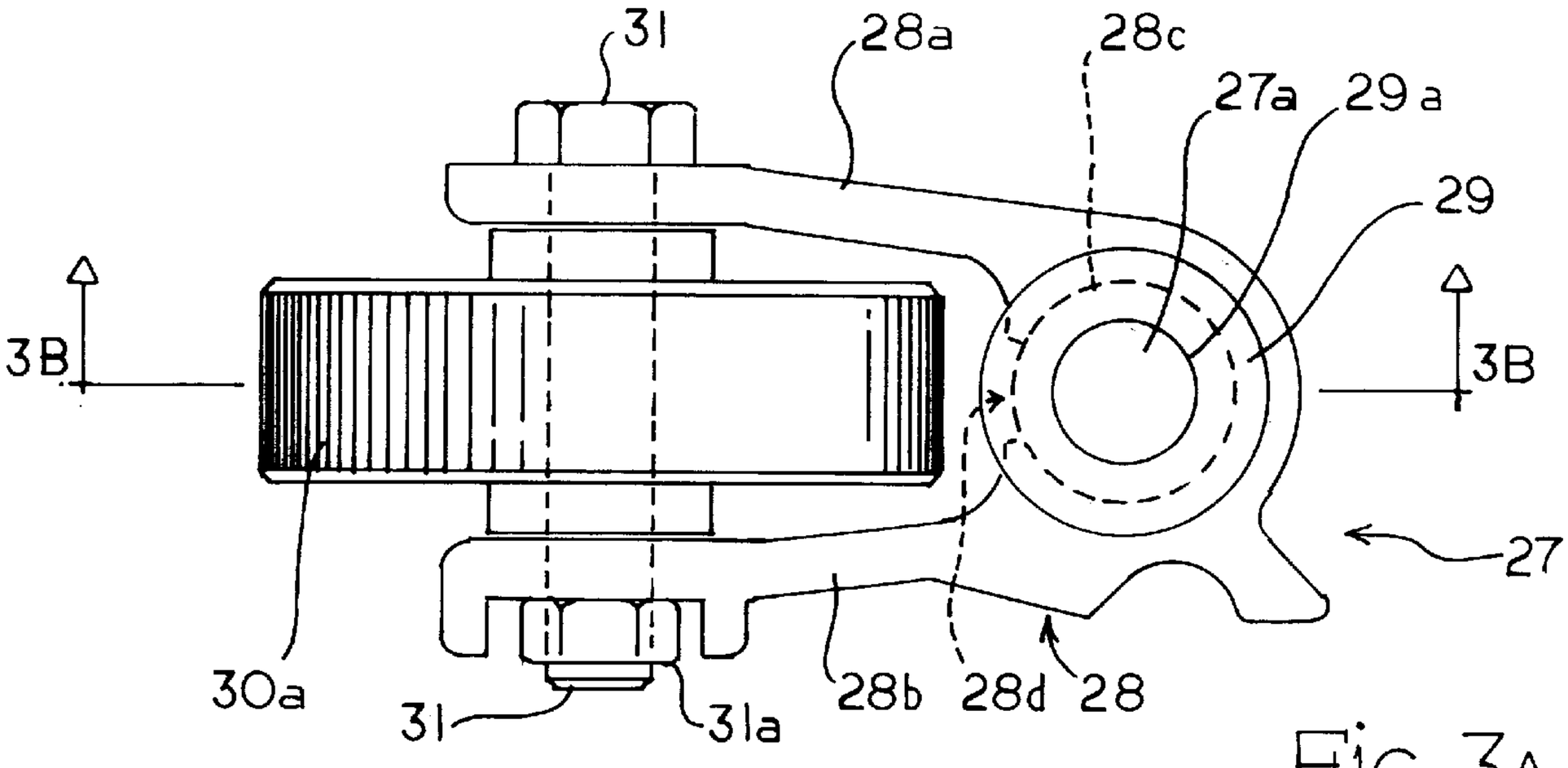
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Fig. 3A

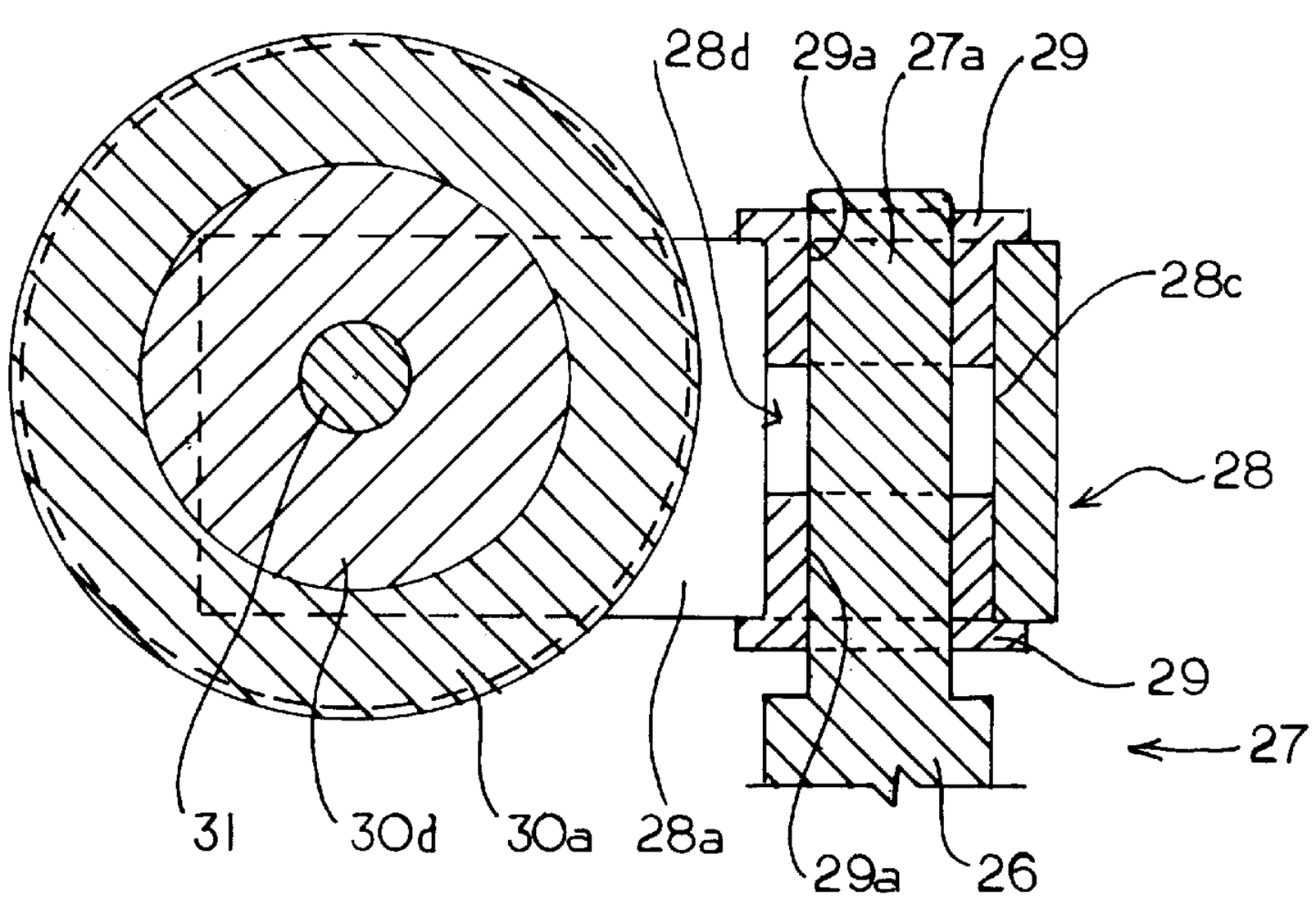
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Fig. 3B

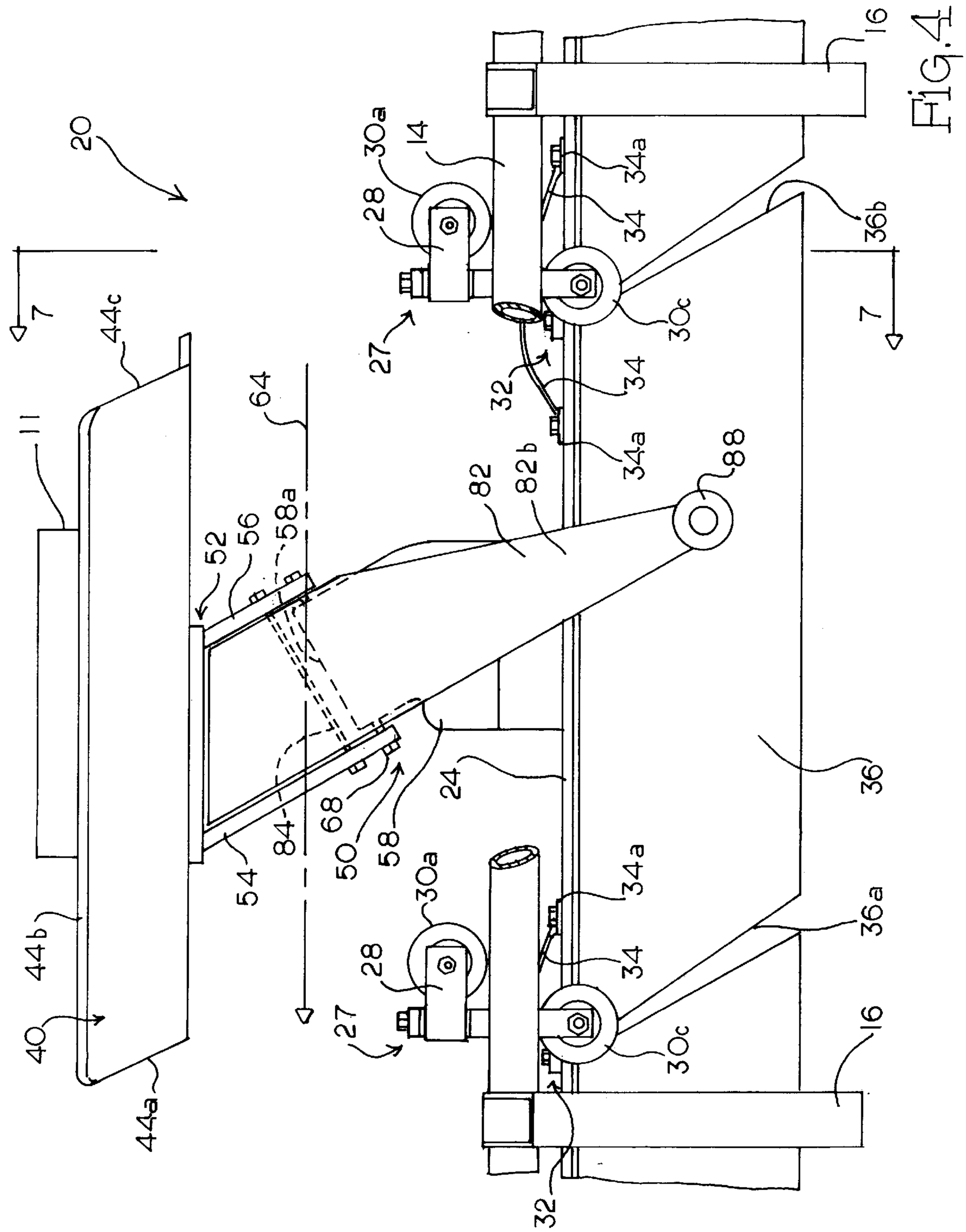
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Fig. 4

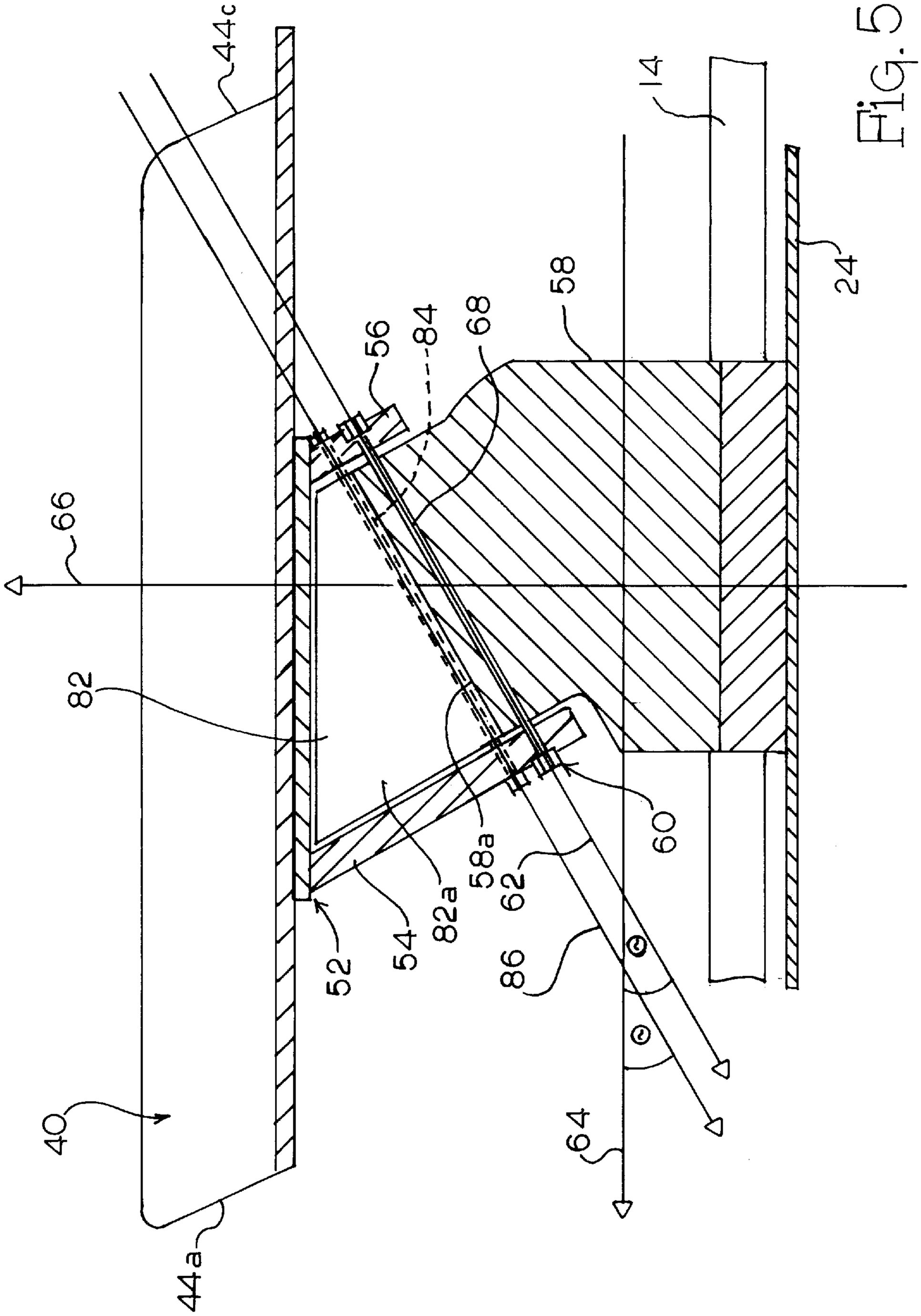

Fig. 5

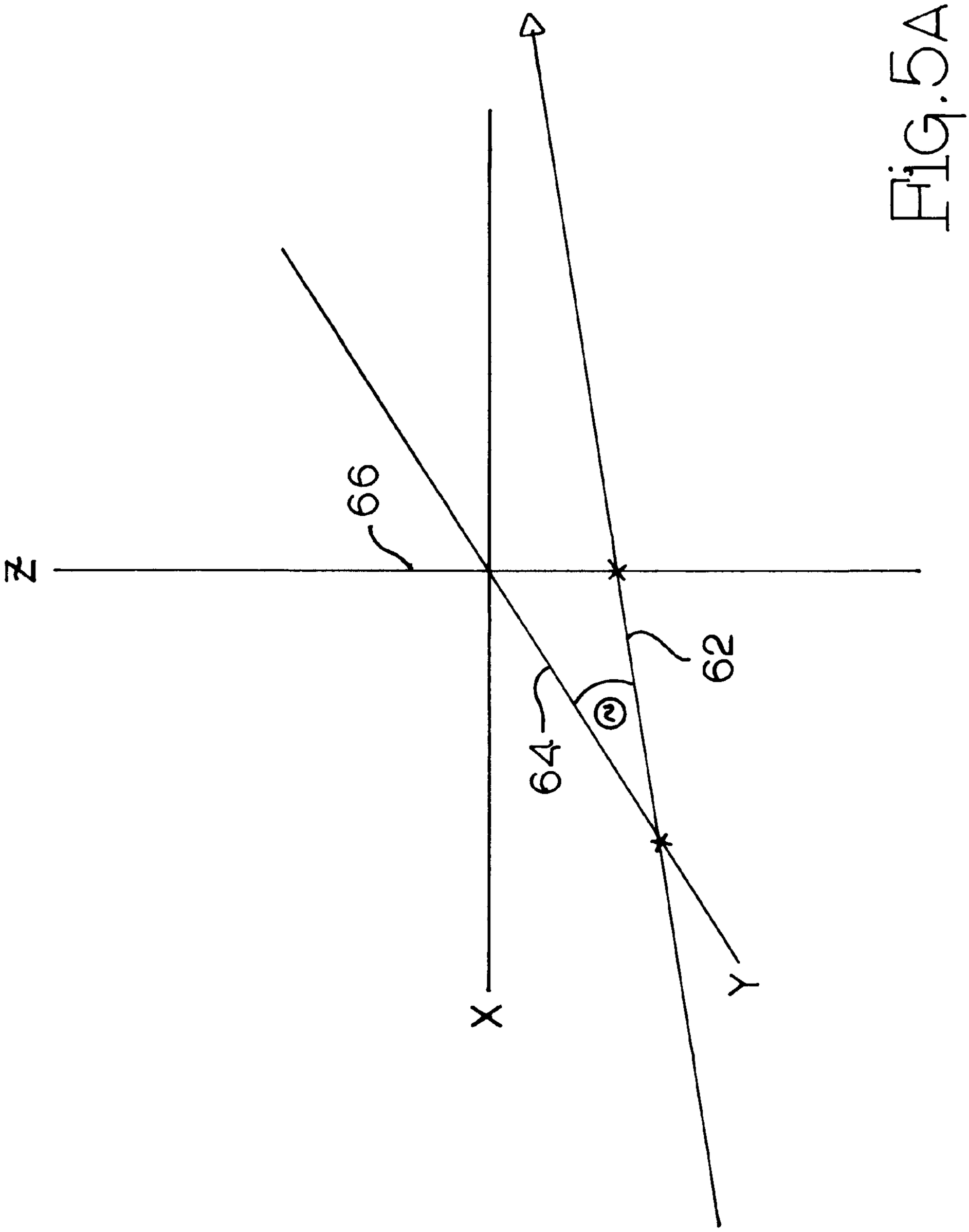

Fig. 5A

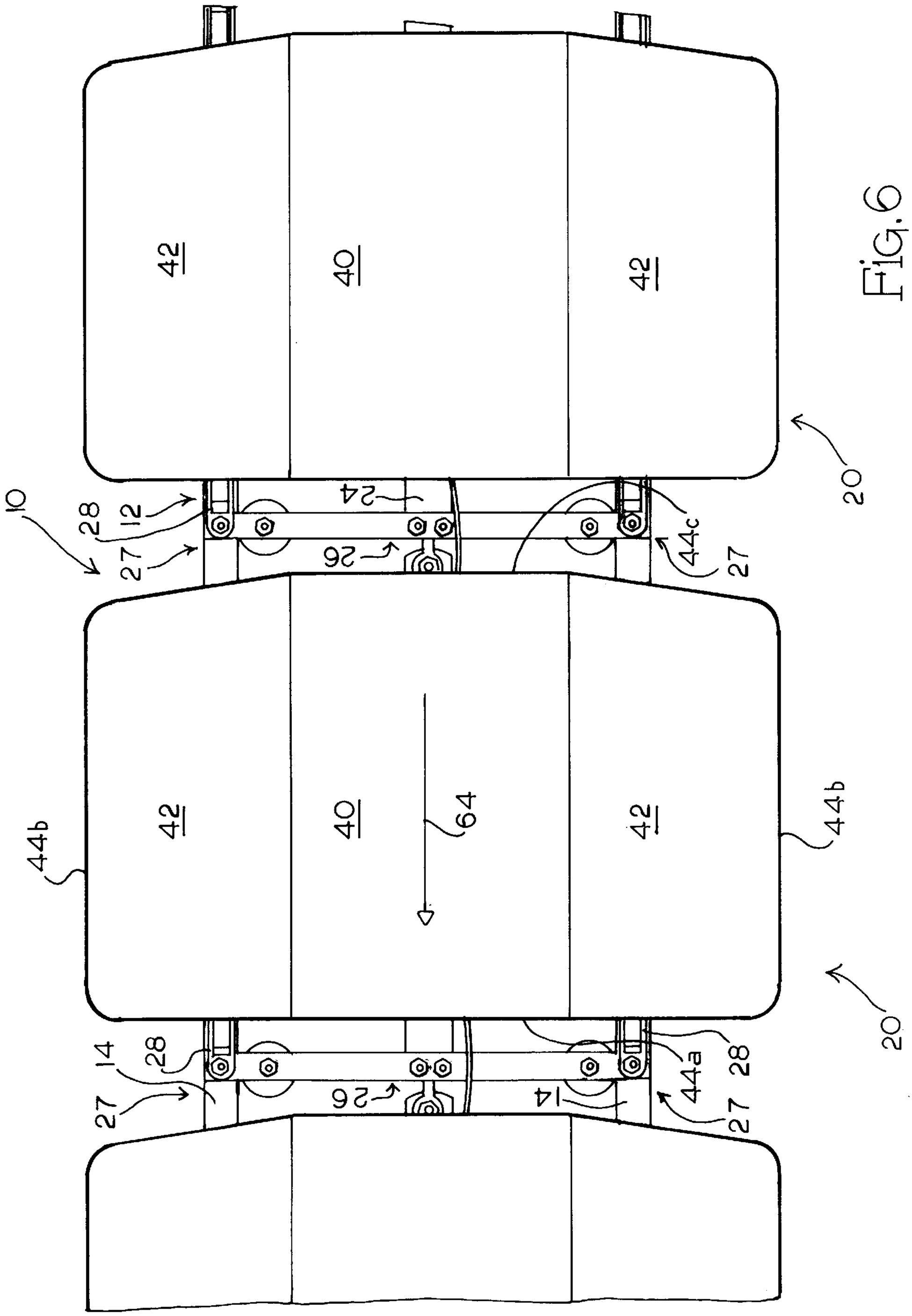
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Fig. 6

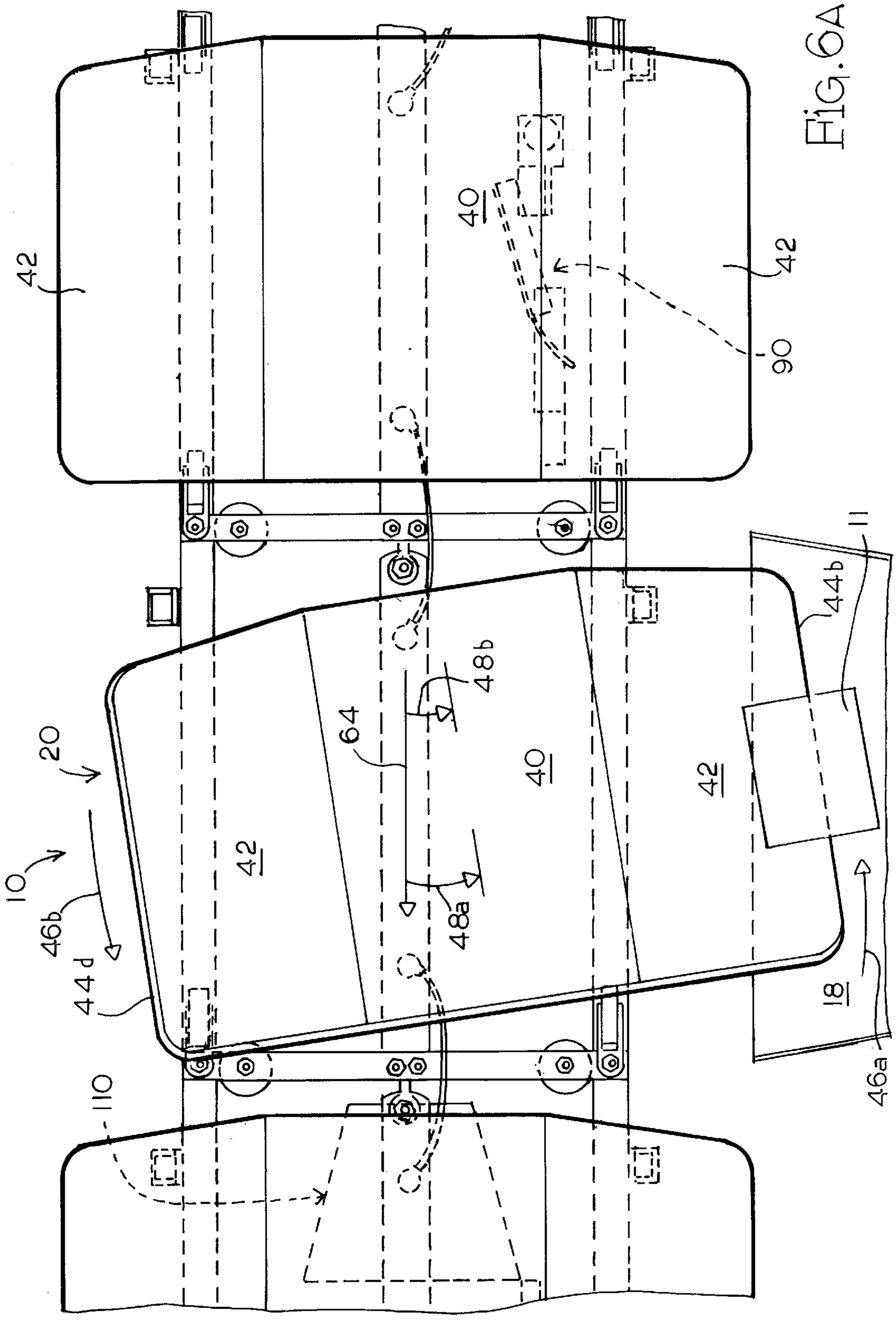

Fig. 6A

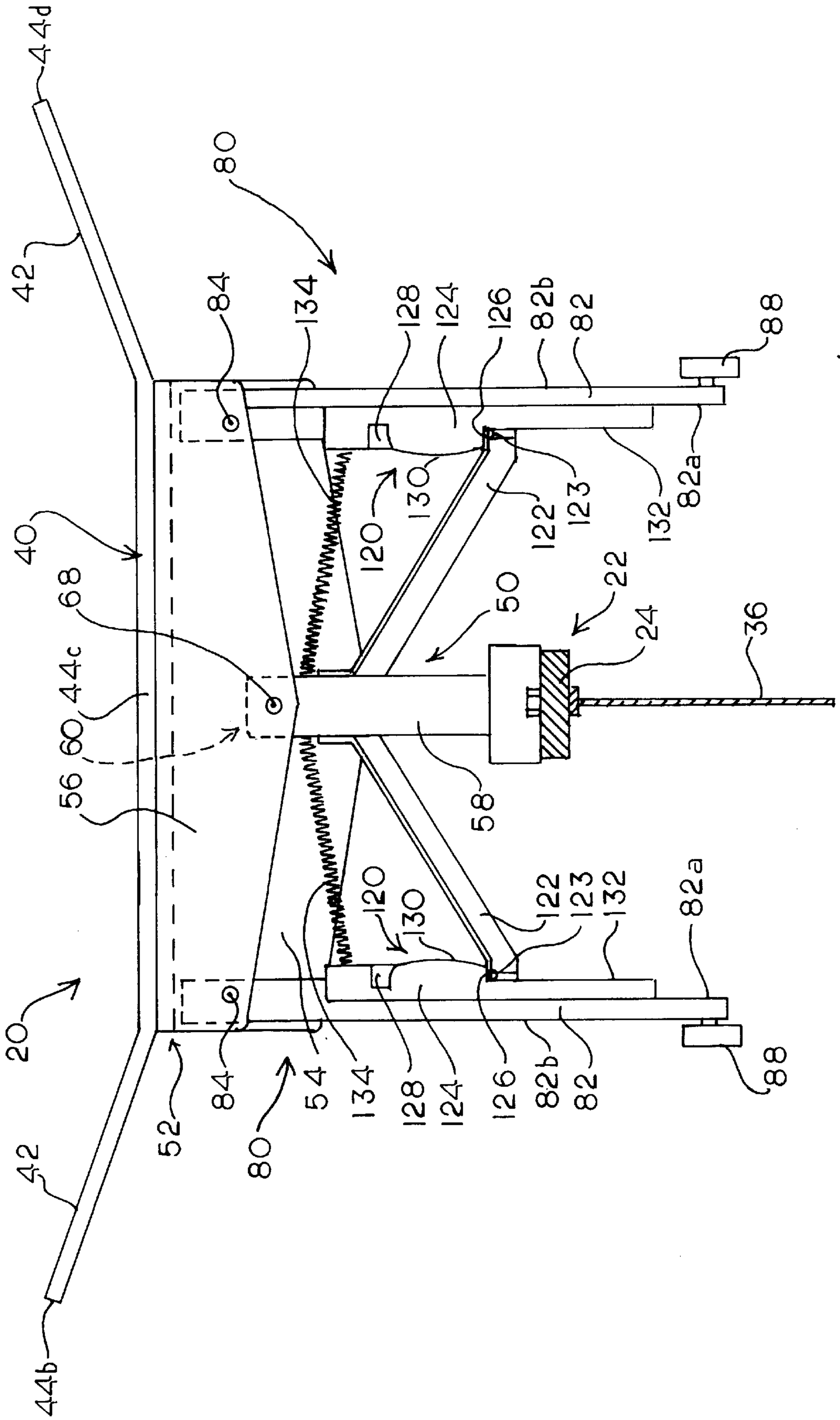
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FIG. 7

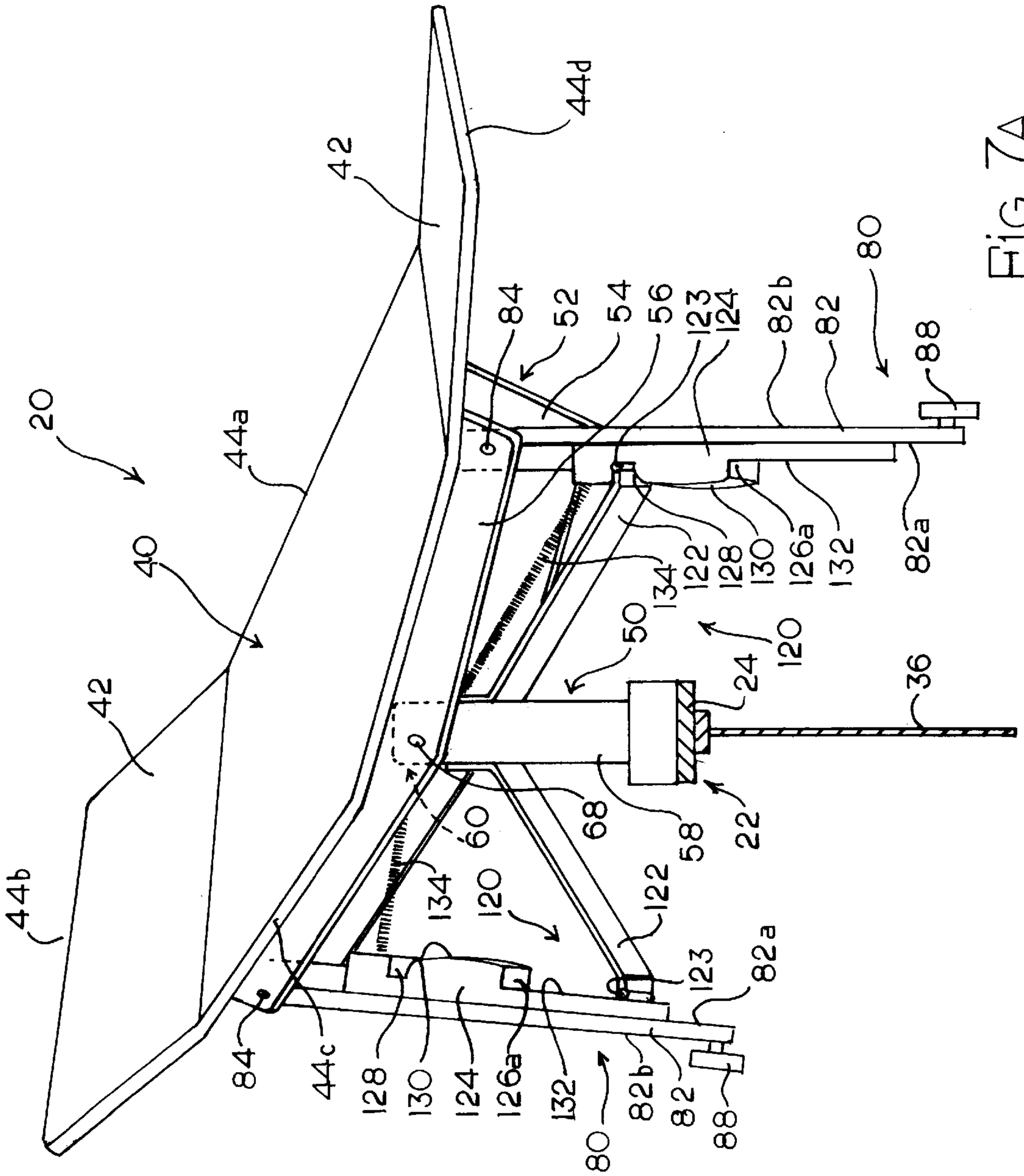
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FIG. 7A

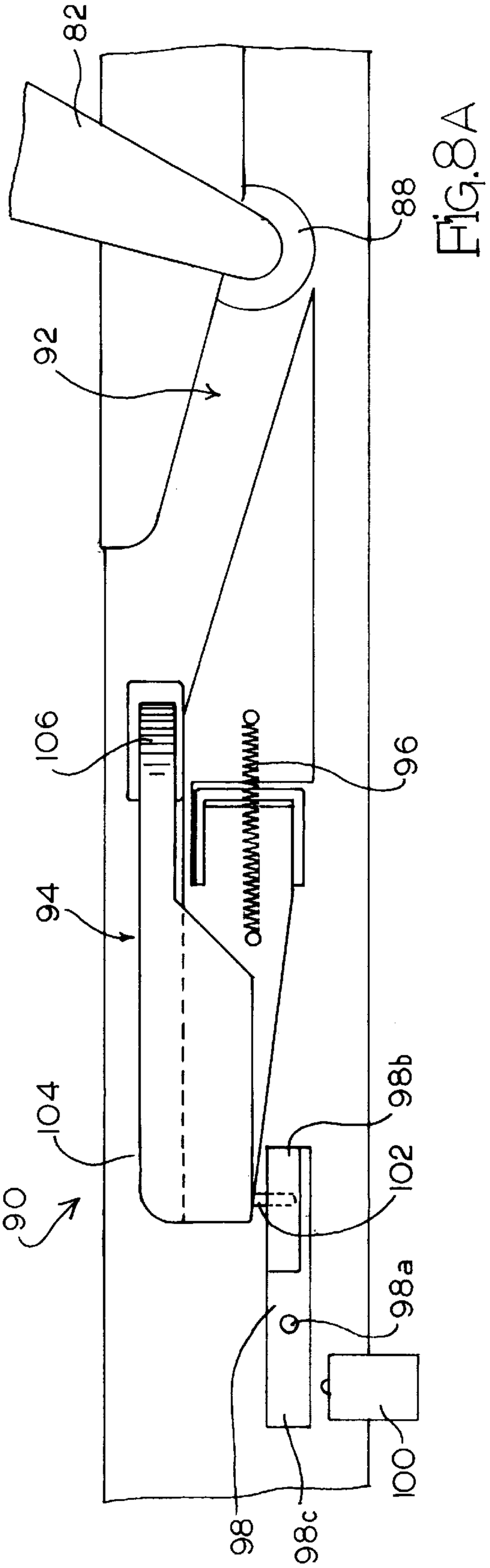
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Fig. 8A

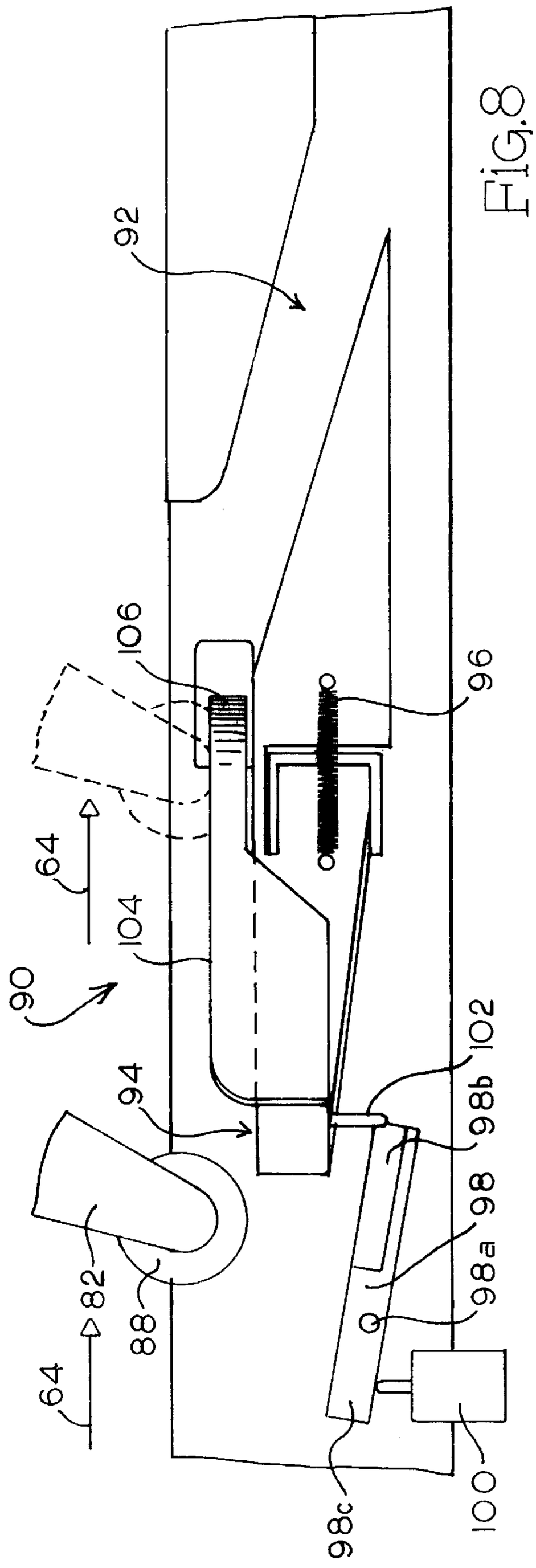
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Fig. 8

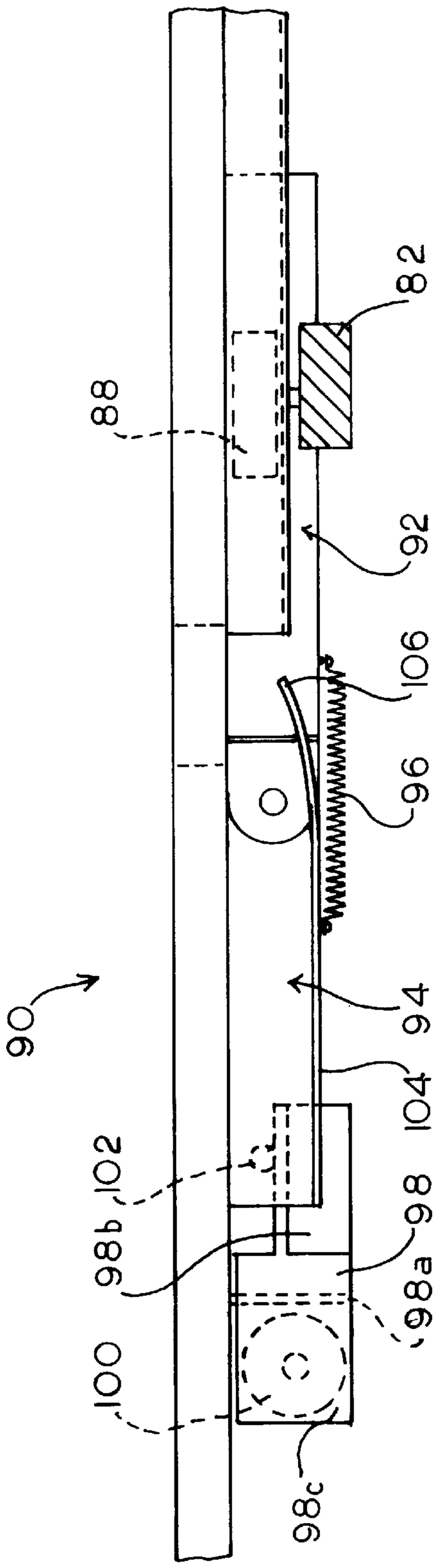
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Fig. 9A

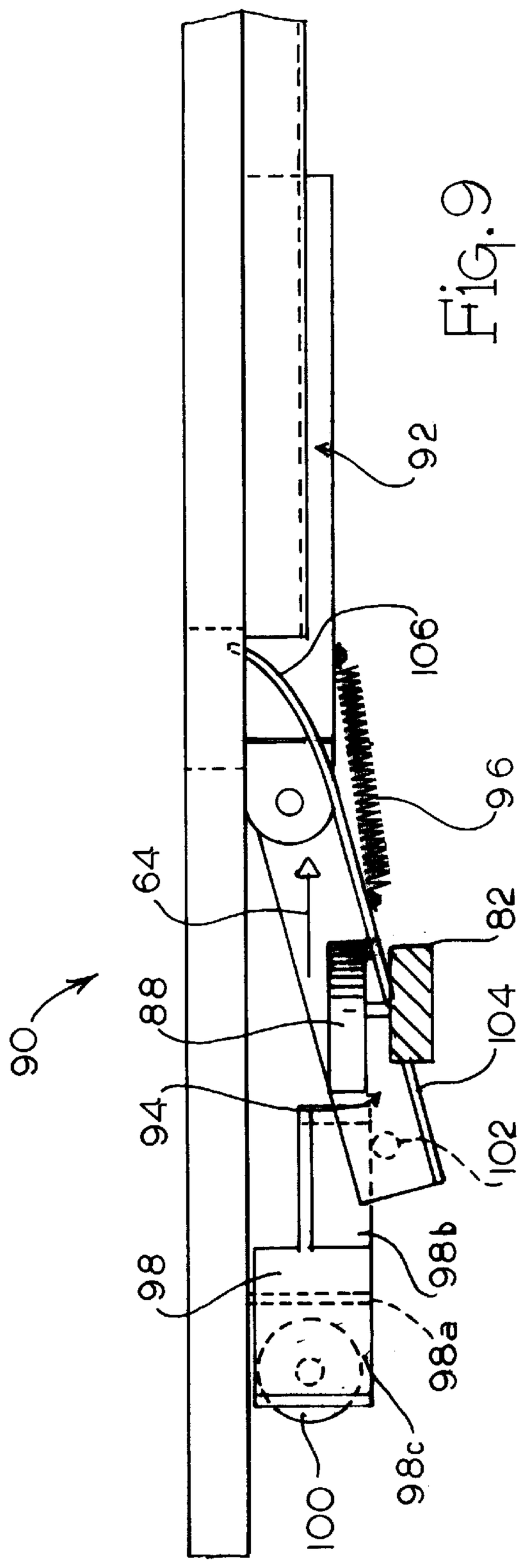
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Fig. 9

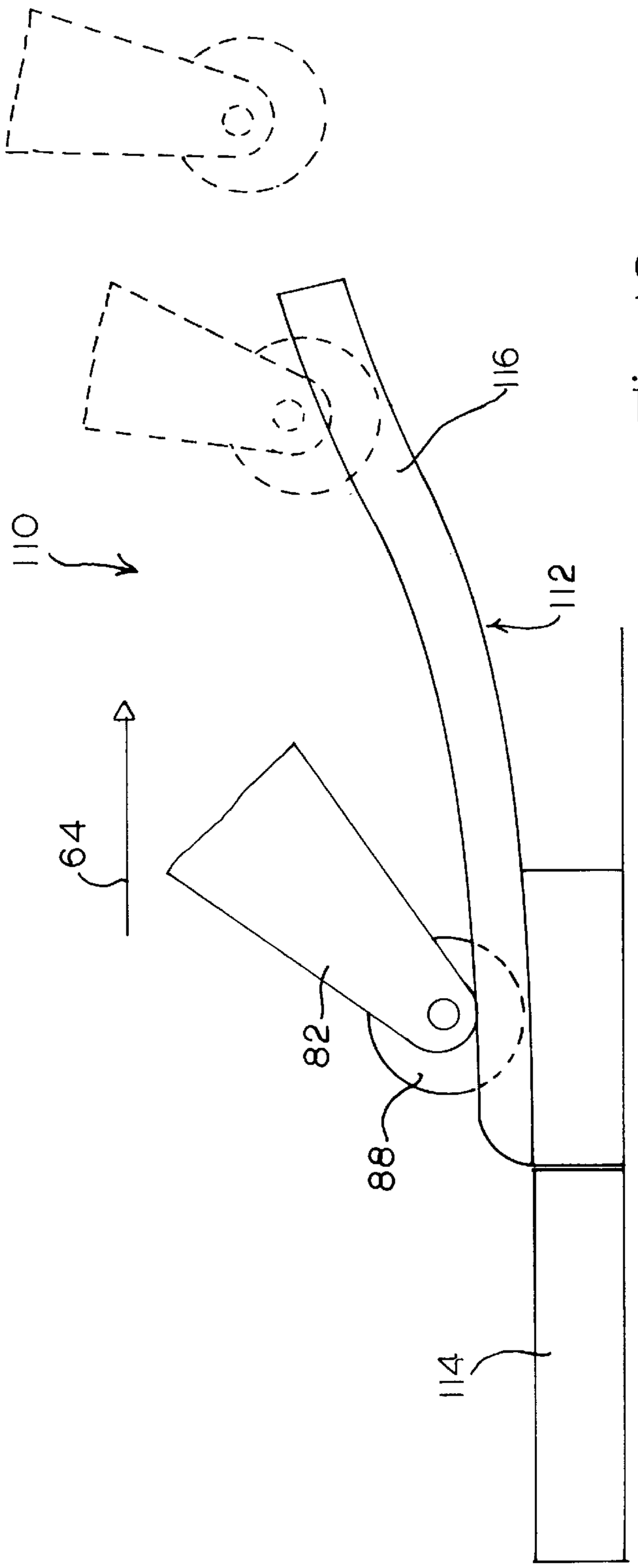

FIG. 10

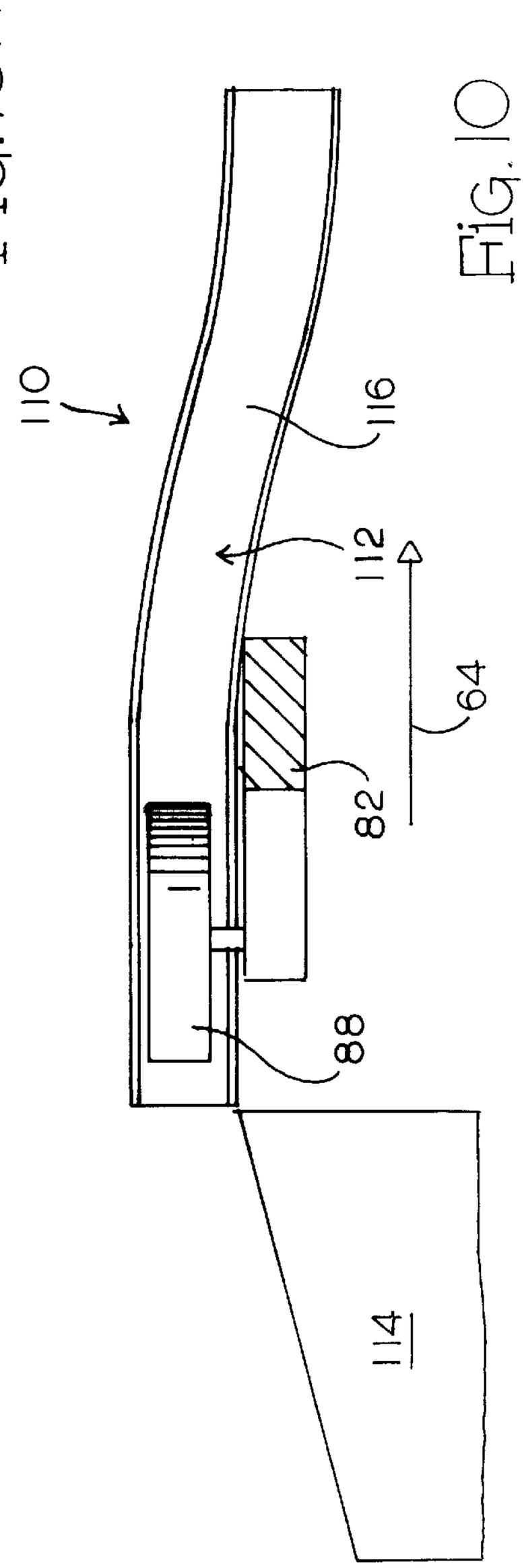

FIG. 10

TILTING CART FOR A PACKAGE SORTING CONVEYOR

This application is a continuation of Ser. No. 08/632,012 filed Apr. 15, 1996 now U.S. Pat. No. 5,836,436.

BACKGROUND OF THE INVENTION

(1) Field of the Invention

The present invention relates generally to package sorting conveyors and more particularly relates to a tilting conveyor cart, which includes a carrying tray that tilts along a pivot axis disposed at an angle to the conveyor's line of travel.

(2) Description of the Related Art

Conveyor systems having a number of individual carrying carts have been commonly used for many years to carry and sort packages or other items, such as mail. For example, U.S. Pat. No. 5,054,601 to Sjogren et al. discloses a package sorting conveyor comprised of a train of tilt tray carriers coupled in tandem to form a continuous loop. Each carrier includes a pivotally mounted tilt tray normally maintained in an upright position. The carriers are moved around the loop by a series of motors spaced around the loop. Branching out from the loop are outfeed chutes or the like for receiving packages from the carriers. When a particular carrier holding a particular package to be sorted reaches a selected outfeed chute, an actuator tilts the tray to dump the package into the outfeed chute. Another example of a typical package sorting conveyor is disclosed in International PCT Application Number PCT/DK90/00047 of Kosan Crisplant A/S.

One significant disadvantage of conventionally designed package sorting conveyors is that conventional conveyor carriers laterally tilt only on a horizontal axis parallel to the direction of conveyor travel. While this accomplishes the objective of dumping the package from the carrier into an outfeed chute or the like, the package is often roughly tumbled or rolled, sometimes damaging the package's contents. One reason for this is that the packages typically are unloaded from the carrier while still traveling forward at the same speed as the conveyor. Thus, packages tend to slam into a forward retaining wall of the outfeed chute before sliding down the chute. Another problem with conventional laterally tilting conveyors is that because the packages are moving forward at full speed when they are unloaded into the outfeed chute, the outfeed chute must be relatively wide so that packages do not miss the chute and fall off the conveyor past the chute. This often unnecessarily increases the overall size of the conveyor system.

U.S. Pat. No. 4,744,454 and an improvement thereto, U.S. Pat. No. 5,086,905, both to Pölling, disclose previous attempts to remedy this problem of rough handling by conventional laterally tilting conveyor carriers. Both of these patents to Polling disclose a conveyor element for a package conveyor that includes a tilting carrier tray mounted to be rotatable about two swivel axes. A first swivel shaft extends obliquely downward from the underside of the carrying tray and is in turn connected at an angle to the end of a second swivel shaft extending obliquely upwards from a base support part of the conveyor element. Together, the two swivel shafts form a "V" that points in the direction of conveyor travel. Both of the swivel shafts lie in the vertical plane of symmetry of the conveyor element when the carrier tray is disposed in its upright position.

Because the carrier tray of Pölling rotates about two oblique axes, the carrier tray can be tilted not only lateral on a horizontal axis, but is moved through a geometrically

complex spatial reorientation during package discharge. This allows for more gentle placement of a package on an outfeed chute than can be accomplished using conventional conveyor trays that laterally tip on only a horizontal axis. The Pölling conveyor element more gently handles the packages by imparting some degree of rearward velocity to the packages as they are discharged, which, when added to the forward velocity of the conveyor system, results in the packages' forward velocity during discharge being less than that of the conveyor system itself.

However, the conveyor elements of both of Pölling's patents are unduly complicated and intolerant of manufacturing discrepancies. In fact, the second Pölling conveyor element (U.S. Pat. No. 5,086,905) was invented in an attempt to simplify the original design disclosed in the first Pölling patent (U.S. Pat. No. 4,744,454), which had proved to be too expensive and complicated to manufacture efficiently. As a result of this complexity and cost, the Polling devices have not enjoyed significant commercial acceptance and success.

Thus, there remains a need for a new and improved tilting conveyor tray that is capable of gently unloading packages into an unloading station by simultaneously tilting the carrying tray about both a lateral tipping axis and a vertical rotational axis so as to slow down the packages as they are being unloaded, while at the same time having an uncomplicated design that is inexpensive and simple to manufacture and service.

SUMMARY OF THE INVENTION

The present invention is directed to a conveyor cart for a sorting conveyor for transporting objects and unloading objects at one or more unloading stations adjacent the conveyor. Generally, the sorting conveyor includes: a conveyor track; a train of the tilting conveyor carts connected end-to-end; and a power source for moving the conveyor carts on the conveyor track. Each of the tilting conveyor carts includes a trailer frame base. The trailer frame includes a roller structure for engaging the conveyor track, a driven member responsive to the power source, and a hitch mechanism for connecting each tilting conveyor cart to an adjacent conveyor cart. The conveyor cart also includes a carrying tray for holding the objects and a two-axis tiltable support apparatus for supporting the carrying tray above the trailer frame base and for allowing tilting of the carrying tray towards at least one side of the conveyor to unload objects into unloading stations on at least one side of the conveyor.

The two-axis tiltable support apparatus includes an upper support structure joined to the carrying tray, a lower support structure joined to the trailer frame base, and an angled pivot structure connecting the upper support structure to the lower support structure along a pivot axis, wherein the pivot axis is disposed at an angle to a line of travel of the sorting conveyor so as to impart two axial components to the tilting of the carrying tray.

Finally, a tilting mechanism tilts the carrying tray on the tiltable support apparatus to thereby unload objects into one of the unloading stations adjacent the conveyor.

Accordingly, one aspect of the present invention is to provide a conveyor cart for a sorting conveyor for transporting objects and unloading objects at one or more unloading stations adjacent the conveyor, the sorting conveyor includes: a conveyor track; a train of the tilting conveyor carts connected end-to-end; and a power source for moving the conveyor carts on the conveyor track. Each of the tilting conveyor carts comprises: (a) a trailer frame base, including:

(i) a roller structure for engaging the conveyor track, (ii) a driven member responsive to the power source, and (iii) a hitch mechanism for connecting each tilting conveyor cart to an adjacent conveyor cart; (b) a carrying tray for holding the objects; and (c) a tiltable support apparatus for supporting the carrying tray above the trailer frame base and for allowing tilting of the carrying tray towards at least one side of the conveyor to unload objects into unloading stations on at least one side of the conveyor, the tiltable support apparatus including: (i) an upper support structure joined to the carrying tray, (ii) a lower support structure joined to the trailer frame base, and (iii) an angled pivot structure connecting the upper support structure to the lower support structure along a pivot axis, wherein the pivot axis is disposed at an angle to a line of travel of the conveyor cart so as to impart two axial components to the tilting of the carrying tray.

Another aspect of the present invention is to provide a two-axis tiltable support apparatus for supporting a carrying tray on a conveyor cart of a package sorting conveyor and for allowing tilting of the carrying tray towards at least one side of the package sorting conveyor to unload packages into unloading stations on at least one side of the sorting conveyor. The tiltable support apparatus comprises: (a) an upper support structure joined to the carrying tray; (b) a lower support structure mounted atop a frame structure of the sorting conveyor cart; and (c) an angled pivot structure pivotally connecting the upper support structure to the lower support structure along a pivot axis, wherein the pivot axis is disposed at an angle to a line of travel of the sorting conveyor so as to impart two axial components to the tilting of the carrying tray.

Still another aspect of the present invention is to provide a conveyor cart for a sorting conveyor for transporting objects and unloading objects at one or more unloading stations adjacent the conveyor, the sorting conveyor includes: a conveyor track; a train of the tilting conveyor carts connected end-to-end; and a power source for moving the conveyor carts on the conveyor track. Each of the tilting conveyor carts comprises: (a) a trailer frame base, including: (i) a roller structure for engaging the conveyor track, (ii) a driven member responsive to the power source, and (iii) a hitch mechanism for connecting each tilting conveyor cart to an adjacent conveyor cart; (b) a carrying tray for holding the objects; (c) a two-axis tiltable support apparatus for supporting the carrying tray above the trailer frame base and for allowing tilting of the carrying tray towards at least one side of the conveyor to unload objects into unloading stations on at least one side of the conveyor, the tiltable support apparatus including: (i) an upper support structure joined to the carrying tray, (ii) a lower support structure joined to the trailer frame base, and (iii) an angled pivot structure connecting the upper support structure to the lower support structure along a pivot axis, wherein the pivot axis is disposed at an angle to a line of travel of the sorting conveyor so as to impart two axial components to the tilting of the carrying tray; and (d) a tilting mechanism for tilting the carrying tray on the tiltable support apparatus to thereby unload objects into one of the unloading stations adjacent the conveyor.

These and other aspects of the present invention will become apparent to those skilled in the art after a reading of the following description of the preferred embodiment when considered with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic depiction of a package sorting conveyor constructed according to the present invention;

FIG. **2** is front, elevational view of a single tilting conveyor cart of the package sorting conveyor and the power source of the conveyor;

FIG. **3** depicts a train of trailer frame structures of the conveyor carts, as seen from the top, but with the tiltable support apparatuses and the carrying trays of the conveyor carts removed for clarity;

FIG. **3**A depicts a top view of an axle caster that holds a roller wheel on one of the conveyor carts;

FIG. **3**B is a cross-sectional view of the axle caster and roller wheel of FIG. **3**A, taken along lines **3**B—**3**B;

FIG. **4** is an elevational side view of one of the tilting conveyor carts of the present invention;

FIG. **5** is a sectional side view of a tilting conveyor cart, taken along lines **5**—**5** of FIG. **2**, which shows the tiltable support apparatus and the angled pivot structure of the tilting conveyor cart of the invention;

FIG. **5**A is a geometric depiction of the conveyor cart pivot axis and conveyor line of travel as they relate to three-dimensional X,Y,Z spatial coordinates;

FIG. **6** is a top view of the train of carts of the package sorting conveyor of the present invention;

FIG. **6**A shows the train of carts of FIG. **6**, but with one of the carts in its tilted position and unloading a package onto an unloading station beside the sorting conveyor track;

FIG. **7** is a rear view of the tilting conveyor cart taken along lines **7**—**7** of FIG. **4** with the track rails and the roller structure omitted for clarity, which shows the conveyor cart in its upright, horizontal position;

FIG. **7**A shows the tilting conveyor cart of FIG. **7** in its tilted position;

FIG. **8** is a side elevational view of the pull-down mechanism of the invention with its switch in an open position as it captures a passing roller wheel on a conveyor cart actuating arm;

FIG. **8**A is another side view of the pull-down mechanism, except with the roller wheel traveling through the descending ramp and the switch in its closed position;

FIG. **9** is a top view of the pull-down mechanism with the switch in its open position, capturing a passing roller wheel;

FIG. **9**A is another top view of the pull-down mechanism, except with the roller wheel traveling through the descending ramp and the switch in its closed position;

FIG. **10** is a top view of the push-up mechanism; and

FIG. **10**A is a side view of the push-up mechanism.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the following description, like reference characters designate like or corresponding parts throughout the several views. Also in the following description, it is to be understood that such terms as "forward", "rearward", "left", "right", "upwardly", "downwardly", and the like are words of convenience and are not to be construed as limiting terms.

Referring now to the drawings in general and FIG. **1** in particular, it will be understood that the illustrations are for the purpose of describing a preferred embodiment of the invention and are not intended to limit the invention thereto. As seen in FIG. **1**, a sorting conveyor, generally designated **10**, is shown constructed according to the present invention for transporting and sorting packages **11** or other objects. The sorting conveyor **10** comprises a train of individual carts **20**, connected end to end, which preferably form an endless loop around a closed-circuit conveyor track **12**. Alternately,

the conveyor carts **20** of the invention could be used singly or as part of a finite train.

The package sorting conveyor **10** generally includes four major sub-assemblies: a conveyor track **12**; a power source **70**; the train of tilting conveyor carts **20**, which are moved along the conveyor track **12** by the power source **70**; and a tilting mechanism **80** for tilting the conveyor carts **20** to discharge packages **11** therefrom. Typically, any number of unloading stations or outfeed chutes **18**, which are adjacent the package sorting conveyor **10** on one or both sides thereof, receive the packages **11** discharged from the sorting conveyor **10** and carry the packages to waiting storage bins, trucks, etc. Packages may be manually placed on the conveyor carts **20** or may be delivered to the sorting conveyor **10** via infeed chutes **17** or the like.

The conveyor track **12** includes two parallel rails **14** and may be built to conform to the layout of any warehouse, shipping center, distribution center, or the like. Best seen as resembling the track of a roller coaster, the conveyor track **12** may be substantially horizontal or may ascend and descend. The conveyor track rails **14** may lie in the same horizontal plane, or one may be higher than the other, such as would be the case in a banked curve in the track **12**. Banked curves are greatly advantageous because they allow the conveyor carts **20** to move around a curved conveyor track **12** at a much greater speed without spilling packages **11** than on a flat track. Preferably, the rails **14** are generally tubular, again similar to a roller coaster, and are supported by rail support members **16** only on the outwardly facing edges of the rails. The rails **14** may be round or rectangular in cross-section. Rectangular cross-section is preferred since it has been found that round rails cause the roller wheels to wear somewhat in their center because the load is not as well distributed as when rectangular rails are utilized.

The power source **70** of the sorter conveyor **10**, which is shown in FIG. **2**, is preferably a vertically oriented linear induction motor (LIM). The vertically oriented LIM **70** of the present invention is an improvement over previously designed LIM's, which typically are horizontally disposed below the conveyor track. Conventional LIM's also usually depend on the presence of a heavy steel plate in each conveyor cart to provide a pathway through which electromagnetic flux from the electromagnetic coil of the LIM passes, thereby driving the carts along the track. This causes two problems. The first problem is with excessive weight of the conveyor cart train resulting from the presence of the steel plates.

The second problem is with maintaining the proper distance between the electromagnetic coil of the LIM and the conveyor cart, because gravity coupled with magnetic attraction constantly try to pull the conveyor cart downwardly towards the electromagnetic coil. Magnetic attraction, which attracts the cart towards the electromagnetic coil, accounts for approximately ten percent of the force generated by the electromagnetic coil. Longitudinal thrust, which drives the conveyor cart train around the conveyor track, accounts for approximately ninety percent of the force generated by the electromagnetic coil. While the ten percent magnetic attractive force is relatively weak compared to the ninety percent longitudinal thrust force, it is still enough to pull the conveyor cart into contact with the electromagnetic coil, especially when assisted by gravity in a configuration where the LIM is horizontally disposed below the conveyor track. If the conveyor cart is drawn into contact with the electromagnetic coil, the carts are frozen in place because even the ninety percent longitudinal thrust component of the LIM's total force cannot overcome the friction created by the contacting surfaces magnetically held together. This contact and resulting conveyor failure is normally prevented by maintaining a distance between the conveyor cart and the electromagnetic coil with whatever apparatus is used to support the train of conveyor carts moveably on the conveyor track. However, as parts wear, the distance between the conveyor carts and the electromagnetic coil is reduced until contact and resulting conveyor cart seizure is likely to occur.

The LIM **70** of the present invention solves both of these problems in two different ways. First, the conventional steel flux plate is replaced with a second electromagnetic coil **72***b*, which is preferably identical to, but out-of-phase with, a first electromagnetic coil **72***a*. Each electromagnetic coil thus performs the function of the steel plate for the other electromagnetic coil, i.e. electromagnetic coil **72***a* provides a flux path for electromagnetic coil **72***b* and vice versa. Elimination of the conventional steel plate reduces the weight of and, accordingly, the energy required to move the train of conveyor carts **20**.

Second, the LIM **70** is vertically oriented so that a driven fin **36**, which is attached to the bottom of each conveyor cart **20**, hangs downwardly in between the two electromagnets **72***a,b*. Composed of aluminum or other conductive metal, the vertical fin **36** preferably has swept-back front **36***a* and rear **36***b* edges, as shown in FIG. **4**, giving the fin **36** a generally parallelogram shape. Vertically orienting the fin **36** and the LIM **70** greatly reduces problems with maintaining proper spacing between the fin **36** and the electromagnets **72***a,b,* because gravity ceases to be a factor and because the two electromagnets **72***a,b,* both attract the fin **36** equally. This results in the fin **36** being easily maintained equidistant between the two electromagnets **72***a,b* of the LIM **70** of the invention, thereby preventing the fin **36** from contacting one of the electromagnets and being seized in place as described above.

The electromagnets **72***a,b* are out-of-phase with respect to each other so that the inductive force they create will flow in the same direction. In other words, the electromagnets **72***a,b* are electrically out-of-phase while physically opposed to each other so as to supplement each other's inductive forces on the fin **36**, instead of canceling each other out. This helps provide a consistent motive force on the train of conveyor carts because longitudinal thrust remains constant even if the fin **36** is pulled slightly closer to one of the electromagnets **72***a,b* of the LIM **70**. While the longitudinal thrust is thereby increased with respect to the closer electromagnet, the longitudinal thrust with respect to the more distant electromagnet is proportionally decreased. Thus, total longitudinal thrust in the direction or line of travel remains constant even if the fin **36** wavers slightly from side to side. While a small degree of lateral fin movement may occur, the structure of the carts and the opposing pull of the electromagnets **72***a,b* prevent the fin from being pulled into contact with either electromagnet. The LIM **70** ordinarily moves the train of conveyor carts **20** in one direction of travel; however, it can also be reversed if necessary to run the sorting conveyor backwards.

Now turning to the train of tilting conveyor carts **20**, each cart **20** includes three major sub-assemblies, shown best in FIG. **2**: a trailer frame structure **22**, a generally horizontally disposed carrying tray **40** for holding the packages **11**, and a tiltable support apparatus **50** for supporting the carrying tray **40** above the trailer frame structure **22** and for allowing tilting of the carrying tray **40** towards either side of the sorting conveyor **10** to unload a package into one of the unloading stations. Each cart **20** is built around a base trailer

frame structure **22** to which other components of each cart **20** are mounted. As shown in FIG. **3**, the trailer frame structure **22** includes a longitudinal base member **24** that extends in the direction of conveyor travel **64** between the two parallel rails **14**. Preferably, the base member **24** is substantially equidistant from each rail **14**.

A roller structure **26** for riding on the conveyor track **12** is mounted on a front end of the base member **24** and includes two laterally extending roller wheel mechanisms **27**, one for each rail **14**. The reason for the outboard placement of the rail supports **16** and the tubular shape of the rails **14** becomes apparent upon examining the roller wheel mechanisms **27**. Each roller wheel mechanism **27** includes three roller wheels: an upper roller wheel **30***a* for riding on the top edge of the rail **14**, a middle roller wheel **30***b* for riding on an inside edge of the rail **14**, and a lower roller wheel **30***c* for riding on the bottom edge of the rail **14**. With this configuration, it is almost impossible for a cart **20** to jump the track **12**, because a wheel is provided for each directional force (sideways, upward, and downward) that a cart **20** may encounter when traveling along the track **12**. Preferably, each roller wheel **30***a,b,c* is constructed of a somewhat resilient material such as polyurethane to provide for smooth, quiet, relatively vibration-free operation of the sorter conveyor **10**.

Referring now especially to FIGS. **3**A and **3**B, the structure of each roller wheel mechanism **27** that holds the top wheel **30***a* is shown in greater detail. Each top roller wheel **30***a* is retained by an axle caster **28** that is preferably formed from extruded aluminum or the like. The axle caster **28** includes two forks **28***a* and **28***b,* one on each side of the wheel **30***a,* and a bearing bore **28***c* disposed at the juncture of the two forks **28***a,b,* which has an opening **28***d* on one side so that the bearing bore **28***c* communicates with the space between the forks **28***a,b*. A pair of flange bearings **29** seated in the bearing bore **28***c* are disposed around an axle shaft **27***a* extending from the roller structure **26**. Preferably formed of "oilite" or other friction-reducing material, each flange bearing **29** has the form of a top-hat bushing and includes a center hole **29***a* through which passes the axle shaft **27***a*. The roller wheel **30***a* is held in place between the two forks **28***a,b* by a bolt **31** and nut **31***a*. Preferably, the roller wheel **30***a* includes a bearing structure **30***d* disposed around the bolt **31**, which serves as an axle running through the center of the wheel **30***a*.

The axle caster shown in FIGS. **3**A and **3**B represents an improvement over existing axle casters that hold roller wheels. Due to wear, axle casters inevitably tend to become loose and allow the roller wheels to chatter back and forth, which would inhibit smooth, quiet, vibration-free operation of a sorting conveyor. However, previously designed axle casters typically have a bearing around the axle shaft that must be pressed out when worn and replaced with a new bearing that must be pressed in. This requires a press in addition to more time and expense than is desirable in a large sorting conveyor system.

The axle caster **28** of the present invention solves this problem by providing that the flange bearings **29** can easily be slid into place by hand into the bearing bore **28***c* without using a press. Then, to immovably secure the flange bearings **29** inside the bearing bore **28***c,* the forks **28***a,b* are slightly flexed inwardly towards each other as the nut **31***a* is tightened onto the bolt **31** to hold the wheel **30***a* in place. The forks **28***a,b* of the axle caster **28** are therefore formed minutely wider apart than would be necessary to merely hold the wheel **30***a*. When the forks **28***a,b* are flexed inwardly towards each other by tightening the nut **31***a* on the bolt **31**, the opening **28***d* of the bearing bore **28***c* is closed somewhat and the bearing bore **28***c* is itself slightly distorted, securely retaining the flange bearings **29** therein. The flange bearings **29** themselves are, however, not significantly distorted and are free to swivel back and forth on the axle shaft **27***a*. Therefore, the flange bearings **29** can easily and immediately be replaced on-site when worn, eliminating much down-time that would be required if conventionally designed axle casters were used in the conveyor cart **20** of the present invention.

Adjacent carts **20** in the train are connected together using hitch mechanisms **32**. Each hitch mechanism **32** is shown in FIGS. **3** and **4** as including a front hitch **32***a* mounted on the front end of the base member **24** in front of the roller structure **26** and a rear hitch **32***b* mounted on the rear end of the base member. In the embodiment disclosed, each hitch **32***a,b* has a vertical throughbore, through which a hitch pin connector **32***c* is inserted. Preferably, the hitch mechanisms **32** are configured so that the front hitch **32***a* on a rearward cart is disposed overtop of the rear hitch **32***b* on a forward cart. In the alternative, the hitch mechanisms **32** may comprise a poly-directional spherical ball joint mechanism similar in structure to an automotive trailer hitch. In either case, friction between hitch mechanism components is preferably reduced by, for example, lining the hitch components with TEFLON or other relatively friction-free material.

To prevent adjacent conveyor carts **20** from separating should the hitch mechanism **32** accidentally break or become uncoupled, an auxiliary cart connector **34** is preferably connected between the trailer frame structures **22** of adjacent carts **20**. In the preferred embodiment, the auxiliary cart connector **34** is a metal cable or lanyard, although other high-tensile strength materials could be used. In the embodiment depicted, the auxiliary cart connector **34** is an approximately 3⁄16th inch thick metal cable connected to adjacent trailer frame structures **22** with metal mounting connectors **34***a*.

The primary reason that metal is the preferred material for the auxiliary cart connector **34**, besides its strength, is so that the auxiliary cart connector **34** will also serve as a continuous electrical connector between adjacent carts **20**. Electrical continuity between carts **20** is important because of static electricity build-up while the carts **20** are traveling around the conveyor track **12**. However, because the roller wheels **30***a,b,c* are preferably formed of polyurethane (an electrical insulator) and because the components of the hitch mechanism **32** are preferably coated with TEFLON (also an electrical insulator), electrical continuity between adjacent carts **20** would not otherwise be effectively achieved. By electrically connecting the carts **20**, static charges can be bled off from the train, which is important for safety and operational considerations. Thus, the auxiliary cart connector **34** serves two important purposes: first, it physically attaches two adjacent conveyor carts **20** and prevents them from becoming completely separated should the hitch mechanism **32** fail; second, it enables electrical continuity among all of the conveyor carts **20** in the train.

The configuration of the conveyor cart **20** of the present invention, with its forwardly mounted roller structure **26**, particularly structured hitch mechanism **32**, and swept-back fin **36** is a significant improvement over previously designed conveyor carts. In conventional conveyor carts, the roller structures are typically mounted at the rear end of the trailer frame and the rear hitch is disposed overtop of the forward hitch. When a hitch mechanism breaks or becomes accidentally uncoupled with this old configuration, the result is that the forward end of the trailer frame drops below the con-

veyor track and is pushed over underlying structures or the floor, leading to inevitable damage to the sorter conveyor.

With the present design, even without the auxiliary connector cable **34**, only the rear end of the trailer frame structure **22** will drop below the conveyor track **12** upon accidental disengagement of the hitches **32***a,b* or upon breakage of the hitch mechanism **32**. Therefore, instead of the front end **36***a* of the driven fin **36** digging into the floor or underlying structures below the conveyor, as is the case with prior art conveyors, the driven fin **36** will simply be dragged with relatively minimal damage should one of the hitches **32** break or become accidentally uncoupled. If an auxiliary connector cable **34** is attached between two adjacent carts **20** that break apart, the connector cable **34** will limit the distance that the rear end of the trailer frame structure **22** will drop, further limiting damage.

Mounted atop the trailer frame structure **22** of each conveyor cart **20** is the tiltable support apparatus **50**, which supports the carrying tray **40** thereabove. As can best be seen in FIG. **5**, the tiltable support apparatus **50** generally includes three components: an upper support structure **52** joined to a bottom surface of the carrying tray **40**, a lower support structure **58** centrally mounted atop the longitudinal base member **24**, and an angled pivot structure **60** pivotally connecting the lower support structure **58** to the upper support structure **52** along a pivot axis **62**.

In turn, the upper support structure **52** includes a front support member **54** and a back support member **56**. The lower support structure **58** is preferably generally planar, lying in the vertical plane parallel to the conveyor line of travel **64**, and includes an angled upper edge **58***a*. The pivot structure **60** preferably includes an axle **68** that runs either through or along the upper edge **58***a* of the lower support structure **58** and is connected to the front and back support members, **56**, **58**, respectively. Preferably, the axle **68** runs through lower regions of the front and back support members **56**, **58**. As can be seen, the front support member **54** depends farther down from the carrying tray **40** than the back support member **56**. While the lower support structure **58** is stationarily fixed to the trailer frame **22**, the axle **68** allows the upper support structure **52** to pivot along the pivot axis **62** of the pivot structure **60**.

In an alternate embodiment of the tiltable support apparatus (not shown), the upper support structure **52** could also comprise, like the lower support structure **58**, a generally planar member that lies in the vertical plane parallel to the conveyor line of travel **64**. In this case, the angled pivot structure **60** could take on the form of a hinge structure joining together the two generally planar support structures **52**, **58**.

The pivot axis **62** lies in a vertical plane parallel to the conveyor line of travel, which is shown in the drawings as horizontal line **64**. However, unlike conventional sorter conveyor tilting carts, the pivot axis **62** of the conveyor cart **20** of the invention is disposed at an angle θ to the conveyor line of travel **64** so as to impart two axial components to the tilting of the carrying tray **40**. Preferably, the pivot axis **62** is angled downwardly at an angle of approximately 20 to 45 degrees below horizontal in a forward direction. In the embodiment disclosed, the pivot axis **62** is angled downwardly 30 degrees. As can be seen in FIG. **5**, the pivot axis **62** preferably intersects a plane occupied by the carrying tray **40** rearward of the center of the tray **40**.

By disposing the pivot axis **62** at a downwardly directed angle θ instead of parallel to the conveyor line of travel **64**, two axial components are imparted to the tilting motion of the carrying tray **40**. The first axial component of the tray's tilting motion is lateral tipping on a horizontal axis parallel to the conveyor line of travel **64**. The second axial component of the tray's tilting motion is rotating around a vertical axis **66** perpendicular to the conveyor line of travel. Thus, while the tray only tilts along a single, angled pivot axis **62**, the overall motion of the tray **40** as it tilts includes two axial components.

The tilting motion of the tray may also be described using three-dimensional X, Y, and Z-axis spatial coordinates, as shown in FIG. **5**A, wherein the Y-axis is parallel to the conveyor line of travel **64**, the X-axis extends horizontally perpendicular to the line of travel **64**, and the Z-axis extends vertically perpendicular to the line of travel **64**. In the present invention, tilting of the tray **40** includes a Y-axis and a Z-axis component, for as shown in FIG. **5**A the pivot axis **62** intersects the Y and Z axes. Specifically and for illustrative purposes only, using the preferred 37.5 degree downward angle θ of the pivot axis **62**, it can be appreciated that the ratio of Y-axis motion to Z-axis motion is 60:30. In other words, with a 30 degree angle θ, the tray **40** laterally tips somewhat farther than it rotates. If the angle θ of the pivot axis **62** is increased to 45 degrees below horizontal, then the tray will tilt and rotate equally.

As shown in FIGS. **6** and **6**A, one effect of this two-axis tilting of the carrying tray **40** is that a side **44***b* of the tray that is tilted downwardly also rotates rearwardly relative to the cart **20**, as shown in FIG. **6**A by line **46***a*. Side **44***d* of the tray, which is tilted upwardly, rotates forwardly relative to the cart **20**, as shown in FIG. **6**A by line **46***b*. In the preferred embodiment, in which the pivot axis **62** intersects the plane occupied by the tray **40** rear-of-center, the front side **44***a* of the tray **40** rotates a greater distance around the vertical axis **66** than the back side **44***c* of the tray **40**, upon tilting of the tray **40**. As shown in FIG. **6**A, the bisecting center line of the tray **40** rotates farther at its forward end from the horizontal line of travel **64** than at its rearward end. Thus, front side rotation line **48***a* follows a longer arc than back side rotation line **48***b*. By rearwardly rotating whichever side of the tray **40** is being tilted downwardly, some rearward velocity is imparted to packages **11** as they are being discharged from the cart **20** of the invention into an unloading station **18**. Thus, packages are discharged at a lower velocity relative to the unloading station than the velocity of the train of conveyor carts as a whole. This enables the packages to be discharged into a narrower chute than could be accomplished using a conventional conveyor cart. Additionally, because the packages are slowed down somewhat as they are discharged, there is less potential for damage to occur.

As can be seen in the drawings, the tray **40** may also include upwardly angled lateral wings **42** to help prevent packages **11** from accidentally falling off the tray **40**. These wings **42** also decrease the angle of the slope created when the tray **40** is tilted, which helps with gentle handling of the packages **11** as they are discharged from the cart **20**.

When a carrying tray **40** reaches a particular destination unloading station **18**, the tilting mechanism **80** tilts the carrying tray **40** to cause a package **11** carried thereon to be discharged into the unloading station **18**. The tilting mechanism **80** generally includes components mounted on each conveyor cart **20** and components associated with each unloading station **18**. First is a pair of actuating arms **82** attached beneath each cart's carrying tray **40** on opposite lateral sides thereof, one actuating arm **82** on each side of the cart's tiltable support apparatus **50**. Second is a pull-down mechanism **90** immediately upstream from each unloading station **18**. The pull-down mechanism **90**, when activated,

selectively pulls down one of the actuating arms **82** and thereby pulls the respective side of the tray **40** downwardly and rearwardly into the biaxially tilted position described above. Third is a push-up mechanism **110** downstream of the unloading station **18**, which pushes up the actuating arm **82** pulled down by the pull-down mechanism **90** and thereby reorients the tray **40** into its normal, upright position. Fourth is a locking structure **120**, which locks the carrying tray **40** in the tilted position upon pulling down of one of the actuating arms **82**, and which also locks the carrying tray **40** in its normal, upright position upon pushing up of that actuating arm **82**.

Referring now to FIGS. **7** and **7**A, each actuating arm **82** is pivotally attached to the underside of one side of the carrying tray and is preferably connected to the front and back support members, **54** and **56** respectively, of the upper support structure **52**. In the embodiment shown, the actuating arm **82** is attached to the front and back support members by an angled pivot hinge axle **84** that runs through both support members **54**, **56** and through the upper end of the actuating arm **82**. The actuating arm **82** therefore pivots on a pivot axis **86** that is preferably parallel to the pivot axis **62** of the tiltable support apparatus **50**, as shown in FIG. **5**. As can be seen from an examination of the drawings, the actuating arms **82** and their respective pivot axes **86** remain substantially in a vertical plane parallel to the conveyor line of travel **64** when stationary and when being pulled down or pushed up.

Each actuating arm **82** also includes a roller wheel **88**, which engages the pull-down and push-up mechanisms **90**, **110**, as will be described below. The roller wheel **88** is preferably mounted on the lower end of the actuating arm **82** on an outer surface **82***a* thereof. It is conceivable, however, that the roller wheel **88** could be replaced with a friction reducing slide block or other protrusion for engagement by the pull-down and push-up mechanisms **90**, **110**.

Seen in detail in FIGS. **8**, **8**A, **9**, and **9**A, a pull-down mechanism **90** is associated with each unloading station **18** and is located beneath the rail **14** running closest to the unloading station **18** on the upstream side thereof, as indicated in FIG. **6**A. The pull-down mechanism **90** includes a descending ramp **92** and a laterally pivoting switch **94** that, when actuated, pivots open and directs the roller wheel **88** of a passing actuating arm **82** into the descending ramp **92**. As can be seen in the drawings, when the switch **94** is not actuated, the switch is in a closed position parallel to the ramp **92**, and the roller wheel **88** is free to bypass the switch and the descending ramp **92**. However, when a particular package **11** arrives at its destination unloading station **18**, the switch **94** is automatically actuated so that it pivots open into the path of the passing roller wheel **88**, capturing the roller wheel **88**. The roller wheel **88** then rolls through the switch **94**, causing the actuating arm **82** to pivot outwardly somewhat, and into the descending ramp **92**. As the roller wheel **88** rolls through the switch **94**, the roller wheel **88** engages a closure flange **104** having a curved end **106** to thereby pivot the switch **94** back to its closed position, as the roller wheel **88** exits the switch **94** and enters the descending ramp **92**. Next, the descending ramp **92** forces the roller wheel **88** and the associated actuating arm **82** downwardly so as to pull down one side of the tray **40**, thereby discharging the package from the tray **40** into the unloading station **18** adjacent the pull-down mechanism **90**.

A computer controller (not shown) is used to track all packages **11** moving on the conveyor **10** and to automatically actuate a switch **94** at the appropriate time when a particular package **11** reaches its destination unloading station or outfeed chute **18**. The computer is also connected to the LIM **70** to control the movement of the conveyor train and maintain a desirable rate of speed.

In a preferred embodiment of the switch **94**, a biasing member **96**, such as a coil spring, is used to constantly urge the laterally pivoting switch **94** towards its open position. However, to prevent the switch **94** from always remaining open and thereby capturing every passing roller wheel **88**, a lock catch **98** is provided to hold the switch closed. The lock catch **98** pivots on a horizontal pivot member **98***a* between the normal, horizontal position shown in FIG. **8**A, which holds the switch **94** closed, and the tilted position shown in FIG. **8**, which allows the switch **94** to swing open. A catch **102** depending from the forward end of the switch **94** engages an outboard side of the lock catch **98** as the switch is held closed. When the switch **94** is closed by the action of the passing roller wheel **88** on the closure flange **104**, the depending catch **102** slides over a slanted end **98***b* of the lock catch **98** back into position on the outboard side of the lock catch **98**.

Beneath the forward end **98***c* of the lock catch **98** opposite the slanted end **98***b* is a vertically oriented solenoid **100**, which is actuated by the computer controller. Upon receiving a short pulse of electricity from the computer controller, the vertical solenoid **100** pushes the forward end **98***c* of the lock catch **98** upwardly to pivot the lock catch **98** and release the depending catch **102** of the switch **94**. The switch **94** is then swung into its open position by the biasing spring **96**, where it captures the next passing roller wheel **88**.

After the carrying tray **40** has been tilted and a package carried thereon has been discharged into an unloading station **18**, the carrying tray is reoriented into its normal upright position by the push-up mechanism **110**. Seen best in FIGS. **10** and **10**A, a push-up mechanism **110** is associated with each unloading station **18** and is located beneath the track **12** adjacent the unloading station **18** on the downstream side thereof, as indicated in FIG. **6**A. Each push-up mechanism **110** includes an ascending ramp **112** below the rail **14** adjacent the unloading station **18**. The push-up mechanism **110** also includes a wedge-shaped frog **114** that engages the roller wheel **88** on a pulled-down actuating arm **82** and directs the roller wheel **88** into the ascending ramp **112**. The frog **114** is positioned low enough below the track **12** so that roller wheels **88** will be engaged and directed into the ascending ramp **112** only if they have already been pulled down by the pull-down mechanism **90**. As the roller wheel **88** is directed into the ascending ramp **112**, the actuating arm **82** is pivoted outwardly somewhat so that the outside edge **123** of the locking flange **122** will disengage from the tilted position locking channel **127**. To help pull the actuating arm **82** back into substantially vertical alignment after the locking flange **122** has slid over the slide surface **130**, the top of the ascending ramp **112** includes an inwardly turned section **116**.

Now turning to the locking structure **120** of the tilting mechanism **80**, it can be seen best in FIGS. **7** and **7**A that the locking structure **120** includes a pair of locking flanges **122**, a pair of locking blocks **124** mounted one each to the actuating arms **82**, and a biasing member **134** for biasing the actuating arms **82** inwardly into a locked position. Preferably, the locking flanges **122** laterally extend from both sides of the lower support structure **58** of the tiltable support apparatus **50**, although they could also be mounted to the trailer frame structure **22**. In the embodiment disclosed, the locking flanges **122** comprise generally planar steel plates having rollers **123** mounted to their outer edges **123**. In an alternate embodiment, the rollers **123** could be

eliminated and the locking blocks **124** made of a low-friction material on which the roller-less outer edges of the locking flanges **122** could easily slide.

Each locking block **124** is mounted to an inner surface **82***a* of the actuating arm **82** and includes two locking channels **126** and **134** separated by a cammed section **130** having a generally convex outer surface. The lower **126** of the two locking channels receives the roller **123** at the outer edge of the lateral locking flange **122** when the carrying tray **40** is in its upright position. The upper **134** of the two locking channels receives the roller **123** when the carrying tray **40** is in its tilted position. As the tray **40** is tilted from one position to the other, the roller **123** rolls over the cammed section **130** interposed between the two locking channels **126**, **134**. Preferably, the locking blocks **124** are made of a wear-resistant material such as plastic, although other materials could be used. The biasing member, which may be a spring **134**, pulls the actuating arms **82** inwardly so as to engage the locking structure **120** by seating the locking flanges **122** in one of the locking channels **126**, **134**.

During tilting of the tray **40** by the pull-down mechanism **90**, the actuating arm **82** being pulled down is pivoted outward slightly on the pivot axis **86** as the roller wheel **88** is captured by the switch **94** and directed into the descending ramp **92**. This outward pivoting of the actuating arm **82** causes the upright position locking channel **126** to disengage from the locking flange **122**. Then, as the roller wheel **88** is pulled down by the descending ramp **92**, the locking flange **122** rolls upwardly over the cammed section **130**. Because of the curved, convex shape of the cammed section **130** of the locking block **124**, the actuating arm **82** remains substantially vertical as it is pulled down. This helps prevent the roller wheel **88** from slipping out of the descending ramp **92** of the pull-down mechanism **90**. Eventually, the locking flange **122** is seated in the tilted position locking channel **134** as the wheel exits the descending ramp **92** and the tray **40** reaches its fully tilted position. The degree to which the tray **40** is tilted in the fully tilted position can vary depending on the configuration of the locking blocks **124** and the pull-down mechanism **90**. However, in the embodiment disclosed, the tray **40** is tilted approximately 37.5 degrees from horizontal in the fully tilted position.

The biasing member **134** holds the tilted position locking channel **134** and the locking flange **122** together while the cart **20** is moving past the unloading station **18**, stabilizing the tray **40** in the tilted position. Then, when the downwardly pulled actuating arm **82** reaches the push-up mechanism, the arm **82** is pivoted outwardly by the wedge-shaped frog **114** engaging the roller wheel **88**. This outward pivoting causes the locking flange **122** to disengage from the tilted position locking channel **134**. As the roller wheel **88** moves up the ascending ramp **112**, the locking flange rolls downwardly over the cammed section **130**. As the inwardly turned top end **116** of the ascending ramp **112** pivots the actuating arm **82** back to its vertical orientation, the locking flange **122** seats in the upright position locking channel **126**, where it is held in place through the action of the biasing member **134**.

The actuating arm **82** on the opposite side of the conveyor cart **20**, which is not being pulled down or pushed up at a particular unloading station **18**, simply rises and falls with the side of the tray **40** to which it is attached. The locking flange **122** on this side of the cart **20** simply rolls over a flat section **132** of the locking block **124** below the upright position locking channel **126**.

In an alternate embodiment (not shown) of the package sorting conveyor **10** of the invention, the conveyor cart **20** could include a tiltable support apparatus having a pivot axis that is not angled downwardly but that is generally parallel to the conveyor line of travel **64**. In this case, the tilting motion of the carrying tray **40** would only have a single axial component—lateral tipping on a horizontal axis parallel to the conveyor line of travel **64**. While package sorting conveyors having a single-axis lateral tipping motion have been designed in the past, they do not include the other inventive features of the present sorting conveyor **10** such as the vertically oriented LIM **70**, the hitch mechanism **32** and auxiliary cart connector **34**, and the tilting mechanism **80** with its associated components.

Such single-axis conveyor carts would primarily be incorporated into the package sorting conveyor **10** of the present invention for use in sorting particularly large packages that must be carried by two or more adjacent carrying carts **20**. In this case, the trays of the adjacent carts would be simultaneously tilted as the carts reached an unloading station to discharge the package. This would also of course require an especially wide outfeed chute as well as a pull-down mechanism adjacent the unloading station for each cart to be simultaneously tilted.

The reason that single-axis conveyor carts are especially useful for sorting large packages is that it has been found that this double (or triple, etc.) unloading of particularly large packages using the two-axis carrying carts **20** of the present invention occasionally presents difficulties due to the carrying trays **40** not being in the same spatial plane when they are both in their fully tilted positions. Therefore, for double unloading, it is preferable to use the alternate, single-axis embodiment of the conveyor cart.

Several configurations of the package sorting conveyor **10** may be employed that utilize the alternate, single-axis conveyor carts for double unloading situations. A preferable configuration would comprise two adjacent single-axis carts for carrying a single large package. A second configuration would comprise a leading two-axis conveyor cart **20** and a trailing single-axis cart. A third configuration would comprise a leading single-axis conveyor cart and a trailing two-axis conveyor cart **20**. As a whole, the package sorting conveyor **10** of the invention may include both two-axis conveyor carts **20** as well as single-axis conveyor carts interspersed among each other depending on a particular facility's conveying and sorting requirements.

Certain other modifications and improvements will occur to those skilled in the art upon a reading of the foregoing description. It should be understood that all such modifications and improvements have been deleted herein for the sake of conciseness and readability but are properly within the scope of the following claims.

We claim:

1. A sorting conveyor for transporting objects and unloading objects at one or more unloading stations adjacent the conveyor, said sorting conveyor including: a conveyor track; a train of said tilting conveyor carts connected end-to-end; and a linear induction motor for moving said conveyor carts on said conveyor track, each of said tilting conveyor carts comprising:

(a) a trailer frame base, including: (i) a roller structure for engaging said conveyor track, (ii) a metal fin responsive to said linear induction motor, said metal fin being elongated along the longitudinal axis of said cart, and (iii) a hitch mechanism for connecting each tilting conveyor cart to an adjacent conveyor cart, wherein said trailer frame base comprises an auxiliary cart connector for connecting each tilting conveyor cart to

an adjacent conveyor cart to prevent adjacent conveyor carts from separating upon failure of said hitch mechanism;

(b) a carrying tray for holding the objects; and

(c) a tiltable support apparatus for supporting said carrying tray above said trailer frame base and for allowing tilting of said carrying tray towards at least one side of the conveyor to unload objects into unloading stations on at least one side of the conveyor.

2. The apparatus according to claim **1**, further comprising a tilting mechanism for tilting said carrying tray on said tiltable support apparatus to thereby unload objects into one of the unloading stations adjacent the conveyor.

3. The apparatus according to claim **2**, wherein said tilting mechanism comprises:

(a) a pair of actuating arms attached to said carrying tray on opposite sides of said tiltable support apparatus;

(b) a pull-down mechanism associated with each unloading station for selectively pulling down one of said actuating arms so as to pull one side of said carrying tray downwardly and rearwardly into a tilted position; and

(c) a push-up mechanism for pushing up the actuating arm pulled down by said pull-down mechanism so as to reorient said carrying tray into a generally horizontal, upright position.

4. The apparatus according to claim **3**, wherein said tilting mechanism further comprises a locking structure for locking said carrying tray in the tilted position upon pulling down of one of said actuating arms, and for locking said carrying tray in the upright position upon pushing up of said actuating arm.

5. The apparatus according to claim **3**, wherein said actuating arms are each pivotally attached to said carrying tray beneath said carrying tray.

6. The apparatus according to claim **5**, wherein said actuating arms pivot on pivot axes that are orientated with respect to the conveyor line of travel.

7. The apparatus according to claim **6**, wherein the pivot axes of said actuating arms are parallel to the pivot axis of said tiltable support apparatus.

8. The apparatus according to claim **5**, wherein said actuating arms are pivotally attached to said upper support structure of said tiltable support apparatus.

9. The apparatus according to claim **5**, wherein the pivot axis of said pivot structure lies in a vertical plane parallel to the conveyor line of travel, and wherein said actuating arms remain substantially parallel to the vertical plane parallel to the conveyor line of travel during pulling down and pushing up of said actuating arms to tilt said carrier tray.

10. The apparatus according to claim **5**, wherein each of said actuator arms includes a roller wheel on a lower end of said actuator arm, and wherein said pull-down mechanism includes a descending ramp adjacent said conveyor track and a laterally pivoting switch for directing the roller wheel of a selected actuator arm into said descending ramp.

11. The apparatus according to claim **10**, further including means for opening said laterally pivoting switch so as to capture a selected roller wheel and direct the roller wheel into the descending ramp, and means for closing said laterally pivoting switch after capture of the roller wheel.

12. The apparatus according to claim **11**, wherein the means for opening said laterally pivoting switch includes:

(a) a biasing member for urging said switch into an open position;

(b) a lock catch to prevent opening of said switch until a selected time; and

(c) a solenoid for actuating the lock catch so as to permit the biasing member to open said switch.

13. The apparatus according to claim **12**, wherein said solenoid is vertically mounted beneath the lock catch.

14. The apparatus according to claim **11**, wherein the means for closing said laterally pivoting switch includes a closure flange mounted on said switch and responsive to passing of said roller wheel.

15. The apparatus according to claim **5**, wherein each of said actuator arms includes a roller wheel on a lower end of said actuator arm, and wherein said push-up mechanism includes an ascending ramp adjacent said conveyor track, and a wedge-shaped frog for engaging the roller wheel of a pulled-down actuator arm and directing the roller wheel into said ascending ramp.

16. The apparatus according to claim **15**, wherein said ascending ramp includes an inwardly turned section at a top end of said ascending ramp, the inwardly turned section for pivoting said actuator arm inwardly towards said tiltable support apparatus so as to engage a locking structure and lock said actuator arm in place.

17. The apparatus according to claim **4**, wherein said locking structure includes:

(a) a pair of laterally extending locking flanges on opposite sides of said tiltable support apparatus;

(b) a pair of locking blocks mounted to inner surfaces of said actuating arms, each locking block having locking channels that receive said locking flanges; and

(c) a biasing member attached to both actuating arms for biasing said actuating arms towards each other so as to urge said each of said locking flanges into one of said locking channels.

18. The apparatus according to claim **17**, wherein each locking block includes a locking channel associated with the tilted position of said carrying tray, and wherein each locking block includes a locking channel associated with the upright position of said carrying tray.

19. The apparatus according to claim **18**, wherein each said locking flange includes a roller mounted to an outer edge thereof.

20. The apparatus according to claim **19**, wherein each said locking block includes a cammed section between said locking channels over which said rollers on the outer edges of said locking flanges roll.

21. The apparatus according to claim **1**, wherein said conveyor track comprises two parallel rails.

22. The apparatus according to claim **21**, wherein said trailer frame base includes a longitudinal base member that extends between the two parallel rails parallel to the conveyor line of travel.

23. The apparatus according to claim **22**, wherein said roller structure comprises two laterally extending roller wheel mechanisms, one roller wheel mechanism riding on each conveyor track rail.

24. The apparatus according to claim **21**, wherein each said roller wheel mechanism includes an axle caster that holds a roller wheel, each said axle caster including two forks, a bearing bore disposed at a juncture between said two forks, and at least one flange bearing seated within said bearing bore and disposed around an axle shaft extending from said roller structure.

25. The apparatus according to claim **24**, wherein said roller wheel is held in place in said axle caster by a nut and bolt extending through said roller wheel and both of said forks, wherein said axle caster also includes an opening on one side of said bearing bore that communicates with a space between said two forks, and wherein said at least one flange

bearing is secured within said bearing bore by tightening said nut and bolt so as to inwardly flex said two forks towards each other, thereby slightly closing said opening and distorting said bearing bore.

26. The apparatus according to claim **23**, wherein each conveyor track rail is supported only on an outside edge, and wherein each roller wheel mechanism comprises three roller wheels.

27. The apparatus according to claim **26**, wherein each roller wheel mechanism includes an upper roller wheel for riding on a top edge of a track rail, a middle roller wheel for riding on an inside edge of the track rail, and a lower wheel for riding on a bottom edge of the track rail.

28. The apparatus according to claim **23**, wherein the roller wheel mechanisms are forwardly mounted to said longitudinal base member.

29. The apparatus according to claim **1**, wherein the vertically oriented metal fin of said trailer frame base is moved in the conveyor line of travel by said linear induction motor.

30. The apparatus according to claim **29**, wherein said linear induction motor and said metal fin are both vertically oriented beneath said trailer frame base.

31. The apparatus according to claim **30**, wherein said metal fin is generally parallelogram-shaped with rearwardly angled front and rear edges.

32. The apparatus according to claim **29**, wherein said linear induction motor comprises two opposing out-of-phase electromagnets.

33. The apparatus according to claim **1**, wherein said hitch mechanism comprises a front hitch on a front end of said trailer frame base, a rear hitch on a rear end of said trailer frame base, and a hitch connector for connecting the front hitch of one conveyor cart to the rear hitch of an adjacent conveyor cart.

34. The apparatus according to claim **33**, wherein the front hitch is disposed overtop of the rear hitch.

35. The apparatus according to claim **1**, wherein said auxiliary cart connector comprises an electrically conductive cable connected at one end to said trailer frame base and at another end to a trailer frame base of an adjacent conveyor cart.

36. The apparatus according to claim **34**, wherein said sorting conveyor includes at least one single-axis conveyor cart that comprises a tiltable support apparatus having a horizontal pivot axis that is disposed generally parallel to the conveyor line of travel.

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